PEOPLES SCIENCE EDUCATION ABSTRACTS

VOLUME II, 2009

SECOND PEOPLES EDUCATION CONGRESS
II PEC

SCIENCE EDUCATION IN INDIA

जन शिक्षा परिषद्

PEOPLES COUNCIL OF EDUCATION

भारत

INDIA

PEOPLES SCIENCE EDUCATION ABSTRACTS

VOLUME II, 2009

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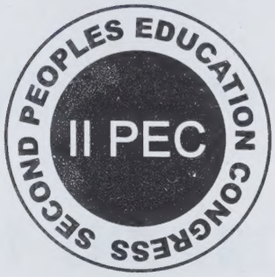

SECOND PEOPLES EDUCATION CONGRESS

FOCAL THEME

SCIENCE EDUCATION IN INDIA

EDITORS

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जन शिक्षा परिषद्

PEOPLES COUNCIL OF EDUCATION

AND

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

INDIA

IN FOND MEMORY

OF

DR. HOMI JEHANGIR BHABHA

ONE OF THE ARCHITECTS

OF

SCIENCE IN INDEPENDENT INDIA

BHABHA CENTENARY YEAR

PEOPLES COUNCIL OF EDUCATION

AND

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION

CONTENTS

Preface

Peoples Council of Education and Homi Bhabha Centre for Science Education (HBCSE), Tata Institute of Fundamental Research (TIFR) jointly resolved to organize the Second Peoples Education Congress on Science Education in India with a view to discovering, developing and disseminating a new democratic system of science education reflecting democratic needs, aspirations and creative urges/potentialities of peoples of India. The resolution was the result of follow-up action on the First Peoples Education Congress on Science Communication, held between Sept. 15 and 17, 2005 at Allahabad. The deliberations on Science Communication had revealed predominance of faulty system of science education in our schools, colleges and universities. The two national institutions— the Peoples Council of Education and the Homi Bhabha Centre for Science Education, TIFR— together constituted a Core Group and a National Academic Advisory Committee for preparing the road-map.

The road-map on **'Science Education in India'** so prepared by the Core Group and National Academic Advisory Committee involved critical appraisal of current system of science education in schools, colleges, universities and research institutes through a series of pre-and-post Congress local, regional and national seminars/symposia/ workshops/ colloquia all over India. Peoples Council of Education and Homi Bhabha Centre for Science Education sought collaboration from almost all universities, several research institutes, national laboratories and academic bodies like NCERT, NUEPA in organization of these events. Though some of them responded very positively but majority of them maintained silence. However, one national workshop was held between March 22 and 24, 2007 at HBCSE (TIFR), Mumbai. Its papers and proceedings were brought out and put on website. Hundreds of copies of the printed book were circulated free of cost.

The Second Peoples Education Congress was originally scheduled to be held between Oct. 02 and 05, 2008, and then shifted to March 11-14, 2009 and finally to Oct. 05-08, 2009. Its postponements did affect participation and preparation, both. It, therefore, became almost difficult to follow or walk on the charted road map. Original plan of printing and circulating the major commissioned papers could not be adhered to. Nevertheless, we have received over 182 papers for presentation at the Second Peoples Education Congress on Science Education and many more are in the pipeline. Quality of these papers is mixed, some are exceptionally good, and some very good, and some are certainly not so good. After a lot of deliberations, the editors decided to retain even those papers which were rejected by the reviewers in order to provide opportunity to the respective contributors to learn from the deliberations of the Congress. What is encouraging to note is that quite a good number of school and college teachers have written papers on science education in schools.

Proposal to organize exhibition on science education has generated good response from all over India. There will be a variety of exhibits depicting innovations in science education at school level. These are quite a large number of individuals, groups, associations and foundations engaged in science education all over India. Some

observers, it is hoped, shall try to put the new ideas behind these exhibits together to form a new thought on science education.

A careful study of the papers published in this volume would reveal that all is not well with science education in India. Why? Because it is completely divorced from the needs, aspirations and creative urges of people of India; because it is divorced from history and culture of Indian science; because its organization is authoritarian, colonial and feudal; because it is imitative and repetitive; because the language of science education is an alien language called English; so on and so forth. What goes in the name of science education is actually scientism or fetishism of science. The papers on **'Medical and Heath Science Education'** show pathetic condition of contemporary Medical Science Education and research in over 296 medical colleges. What is saddening is that the British Medical Science Education system continues without any substantial change even today.

No wonder, if creativity in science in India is on gradual decline; no wonder, if interest of students in science is declining; no wonder if the availability of competent and creative science teachers and research scientists in large number is falling down. Truth is (although bitter): Science today in India is almost bankrupt. It is badly or severely afflicted by poverty of thought.

Solutions being put forward by some scientists and practiced by the Government and the University Grants Commission and NCERT like bodies do not seem matching the dimensions of the problems afflicting science education in India. An erroneous belief that some are born with the innate traits of scientists is being put forward as a solution for promoting excellence in science. Application of tests (of doubtful validity) for selection of students by various bodies, organization of elite competitions, award of various kinds of fellowships, creation of special institutions reflect this line of **'Brahminical thinking'**

What, then, is the solution? There is no easy and quick answer to it. This Congress will certainly not be able to answer it. But it is quite possible to find a satisfactory answer by organizing many more such Congresses in future. What, this Congress may suggest, and which is worth noting, is that the problem of current science education is *systemic* and, as we know, what is *systemic* needs a *systemic solution.* No amount of *non-systemic* solutions will put the science education in India on the right track or on the path of creativity. We, therefore, need to learn to distinguish between systemic and non-systemic ailments if we wish to make science education in our schools, colleges, universities and research institutes, creative and sensitive to the democratic needs and aspirations of our people. This task is, indeed, very arduous and painful.

We hope the readers will find this volume somewhat worthwhile. Their critical criticism will be pleasant reward to our endeavor and effort.

Frankly speaking, English is not our mother tongue. So it is possible one finds linguistic errors in the texts while reading. There may be some omissions and commissions also. We sincerely seek advance apology for the same.

ACKNOWLEDGEMENT

We express our deep gratitude to Peoples Council of Education and Homi Bhabha Centre For Science Education, Tata Institute of Fundamental Research for entrusting us the task of compiling and editing the papers of the Second Peoples Education Congress on Science Education In India. Prof. P.K. Sarkar, the President of Peoples Council of Education and Prof. H.C. Pradhan, the Centre Director of Homi Bhabha Centre placed unconditional their faith in us. Both of them extended their helping hands whenever required. We are, indeed, grateful to Prof. P.K. Sarkar and Prof. H.C. Pradhan.

We also wish to express our deep sense of gratitude to Prof. Arvind Kumar, the former Centre director of Homi Bhabha Centre For Science Education. It was he who piloted the whole conception of Second Peoples Education Congress on Science Education In India and kept his interest in it even after retirement.

We would also like to express our thankfulness to Dr. Chitra Natrajan and Dr. Sugra Chunawala for shouldering the responsibilities of reviewers of papers. Despite being extremely busy they worked very hard to complete the review and submit their recommendations within shortest possible time. We express our sincere thanks to Dr. Chitra Natrajan and Dr. Sugra Chunawala.

Almost all the members of the Executive Council, Organizing Committee, thematic panels and National Academic Advisory Committee extended their support in one way or other. We express our gratitude to all of them.

Organization of the Second Peoples Education Congress has been or is expected to be supported by National Council For Science And Technology Communication, Department of Science And Technology, Ministry of Science And Technology, Department of Higher Education through NUEPA, Ministry of Human Resource Development, Government of India, University Grants Commission, Indian Council of Medical Research, Indian Council of Social Science Research and Board of Research In Nuder Science. We, on behalf of Peoples Council of Education and Homi Bhabha Centre For Science Education express our sincere thanks to each one of them and look forward for their continued support. However, none of them is responsible for views expressed and facts presented in this volume.

We shall be failing in our duty if we do not acknowledge our gratitude to Er. Anuj Sinha, the Advisor and Head, National Council For Science Communication for making substantive contribution to the planning of the Congress on Science Education. He made tremendous contribution to it silently and patiently. We remain grateful to him for ever

We would not have been able to complete our task had we not received unconditional support from Sri. R. Joseph, Sri Mohammad Imran, Sri Mohammad Suyab Siddiqui, Sri Madan Ram Gupta, Sri H.P. Dwivedi, Sri Ram Baran Gupta, Sri Ramchandra, and Sri Sanjay Kumar. All of them worked very hard. Sri Imran and Sri Siddiqui worked to finish the typing work despite Ramjan's Roza. Sri R. Joseph handled the flow of letters and papers till late evening, even on the holidays. Despite being of 83 years, Sri Madan Ram Gupta kept on boosting our morale by his dedicated deeds. We wish to acknowledge our thankfulness to all of them.

N.P. Chaubey
K.K.Mishra
Meena Kharatamal
Sushma

It may be noted that the views expressed and facts presented in this volume are those of their authors and in no way reflect the views of the Peoples Council of Education and Homi Bhabha Centre for Science Education.

Date: Sept 19, 2009

Place: Allahabad

N. P. Chaubey
K. K. Mishra
Meena Kharatmal
Sushma

A NOTE ON
SCIENCE EDUCATION IN INDIA

01. PREAMBLE

Peoples Council of Education shall hold the Second Peoples Education Congress under the auspices of Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research between October 05 and 08, 2009 at Mumbai with a view to discovering, developing and disseminating a new democratic system of science education in Indian schools, colleges and universities reflecting the peoples' democratic needs, aspirations and creative urges.

02. FOCAL THEME

The Peoples Council of Education has resolved to focus the deliberations of the Second Peoples Education Congress on **Science Education In India.**

03. CONTEXT

First Peoples Education Congress deliberated over 'Science Communication'. Its deliberations revealed very poor status of science communication in schools, colleges and universities. It was suggested that qualitative change in science communication in schools, colleges and universities is a must for overall qualitative improvements in and impact of science communication at a national level. The assembly of delegates resolved to focus the deliberations of the Second Peoples Education Congress on "Science Education In India".

Today Indian Education is in deep crisis. Its crisis is deepening day by day. Ever declining creativity and innovativeness in Indian society is highly correlated with the ever declining creativity and innovativeness in the realm of science, technology and art. This is so notwithstanding high rate of growth in educational institutions or so-called high rate of economic growth. Students' declining interest in science education is now worrying the Government as well as the policy planners. Despite Parliament's Scientific Policy Resolution of 1958 placing great faith in self-reliance in the field of Science & Technology, India's dependence on foreign science and technology has been growing rapidly. Even the **'Import-Substitution Policy'** of 1950s has been given goodbye. Now India is seeking advice from **'foreign experts'** for every little thing freely and openly. Even the cricket or hockey coaches have to be imported from abroad. Airport trolleys and coffins have to be imported from abroad. Aero planes have to be bought in foreign markets. All weapons of war and mass destruction had to be purchased from the foreign manufacturers. Even the cleaning of drains and building of bridges require foreign collaboration. So-called huge manpower in Science & Technology, thus, has become redundant. Question is why?

India is now said to be having so-called world-class institutes of Managements and higher learning, yet Indian society is poorly managed. Inefficiency and incompetence are reflected in all spheres of production, distribution, production and social relations. Question is why?

Quite a large number of scientists and technologists working in India are said either having foreign degrees or foreign exposure. Yet the quality of science books taught in schools, colleges and universities are quite inferior in comparison to foreign science books. Moreover, dependence of Indian students on foreign science and technology books and journals are much greater than expected. Science books in Indian languages are still much worse. Question is why?

Coaching institutions in the name of science and technology education have mushroomed all over India. Formal science educational institutions have become meaningless. Certificates and degrees given to students do not carry any value. Question is why?

Suicides by students in IITs and other institutes are rising. Depression among students of schools, colleges, technical institutions is rising. Violence in the school, college and university campuses is on rise. Question is why?

Alienation of scientists and technologists from Nature, Society, Peoples and also from themselves is now visible everywhere. Slavish rather than independence, imitation rather than creativity, authoritarian rather than democratic are the dominant features of personality of majority of Indian scientists. Question is why?

Thus, it is apparent that the question why needs to be investigated thoroughly and comprehensively. While the inquiry into the question **'why'** may take several directions, one direction of central importance is Indian system of education as a whole or **'Indian system of science education'** in particular. A beginning can be made with science education which itself may take several years of collective efforts by a large number of scientists. Slowly but steadily it would be possible to comprehend the Indian system of science education and evolve a new system of science education in India.

The Peoples Council of Education and Homi Bhabha Centre for Science Education, TIFR, therefore, have resolved to focus the deliberations of the Second Peoples Education Congress on **'Science Education in India'**

04. OBJECTIVES

By focusing the deliberations of the Second Peoples Education Congress on **'Science Education in India'**, the Peoples Council of Education and Homi Bhabha Centre for Science Education seek to achieve the following goals:

0401 **To appraise the status of science education in schools, colleges, universities and research institutes and, also its interconnections with humanities and social sciences.**

0402 **To appraise the relevance of contemporary educational institutions and organizations to science education.**

0403 **To determine the appropriateness of syllabi, textbooks and pedagogy of science education in schools, colleges and universities.**

0404 **To determine the nature of relationship between science educational institutions and society and between science teachers and society.**

0405 **To appraise the nature of relationship between science education and democracy and science education and democratic needs and aspirations of peoples and society.**

0406 **To ascertain the nature of social bonds between and among students and teachers.**

0407 **To ascertain the impact of science and technology coaching institutes on science education in schools, colleges and universities.**

0408 **To determine the impact of corporatisation and marketisation on science education in schools, colleges, universities and research institutes.**

0409 **To appraise the impact of commercialization of education on science education.**

0410 To discover, develop and disseminate a new democratic system of science education in congruence with the democratic needs and aspirations of the people of Indian Republic which is capable of flowering the creative and innovative potentialities of all young minds in particular, and peoples of all sections in general.

0411 To discover, develop and disseminate a new democratic system of science communication capable of building bridges between scientists and the people and between and among all sections of the people

05. CONCEPT OF SCIENCE

Science means knowledge as well as the method by which the knowledge is acquired. It is an objective knowledge of non-living and living things including man and society. What does knowledge mean? Knowledge means answer to questions **'what', 'how', 'why'** and **'where'** about a thing or an object. The adjective **'objective'** signifies **'what is within the given thing or object'.** An object or a thing is independent of the knower or the scientist. How to know **'What is within the given object'** is, hence a problematic An individual answers the question what through his perceptual processes. Normally, the perception-based answer is likely to have greater quantity of error, which is corrected to some extent through practice. It calls for verification not only by the perceiver but also by others. It also calls for development and application of a method or methods which is or which are independent and can be used by everyone who wishes to verify the answer. This process of collective investigation and collective verification makes the objective knowledge *social*. Thus, science is by its very nature social. What is social is public. There is no place, therefore, for 'privacy' and **authority** in science.

A thing or an object keeps on changing. Science of a thing or object too changes. That is to say, there is nothing like permanent science or eternal science.

A thing or an object exists in space and time. So science of a thing or an object too is conditioned by space and time. Since a thing or an object has history, so science too has history. That is to say, science too is historical.

There is close and intimate connection between inanimate or non-living thing and animate or living thing and between lower life and higher life. Interconnection, interdependence and interpenetration of one thing into another is the characteristic feature of living and non-living matter. Under certain conditions non-living thing transforms itself to living thing and living thing to non-living thing. The process of transformation is quite complex. Nature contains non-living as well as living objects including man and society. The phrase science of **'Nature-Man-Society'** encompasses all that exist. In other words, science is material in nature, but not the matter itself. Science as a knowledge of Nature-Man-Society is colourless, shapeless and weightless. Science as an objective knowledge of Nature is **unitary**. It is not plural. It is; therefore, wrong to use the word **'Sciences'.** Question is do our schools, colleges and universities communicate this concept of science to students? Do our students and teaches know that their social position may block or distort their science? Do they know that authority has no place in science? Do they comprehend the distinction between science and no-science or between science and metaphysics?

06. CONCEPT OF EDUCATION

Genesis of current system of Education including science education lies in the British rule in India. Macaulay is said to be its founder. It was designed to fulfill the needs of the British rule. It has nothing to do with the democratic needs and aspirations of people of India. Its main character remained colonial and imperialistic.

Independence from the British rule provided a golden opportunity to peoples of India to destroy the colonial education and create a new democratic system rooted in their democratic needs and aspirations. Various attempts through Education Commissions were made in this

direction. But till date the British colonial system of education continues thriving. All new additions are either neo-colonial or feudal providing valuable service to the Corporate World and market forces but injurious to democratic system of education. Slowly but steadily American system of education has made greater inroads in it.

Principles of **'divide and rule'**, **'hierarchy'** and **'sectarian and slavish outlook'** **'marketisation'** and **'commodification'** shaped and continue shaping science education in Indian schools, colleges, universities and research institutes. Science is divided and redivided in superior and inferior categories. Physics, for example, is a superior science and social science is an inferior science. Nuclear physics is far more superior to physics. One who knows physics need not know biology or social science or one who knows social science need not know biology or physics. One who knows economics need not know physics or biology or mathematics. Also, one need not comprehend the interrelationships between non-living and living things/objects. Idea of history or philosophy of science is altogether unwanted or undesirable in science education. There is no place for democracy in science education. How can students be equal to their teachers? Students need not comprehend the concept of science even after completing their doctoral degrees. Competition and not cooperation guide and determine fate of science education in schools, colleges and universities. Good science education in urban areas, and poor science education in rural areas, good science education for the rich and poor science education for the poor. Good science education in English and bad science education in Indian languages. Actually, Indian languages are considered unfit for science education by majority of the university and IIT science professors. Such is the status of science education in India.

Question arises should it continue? Or should it be changed? If it is to be changed how to do it? What should be the parameters of new science education? Democracy? Authoritarianism? Peoples needs and aspirations? Or Corporate World's and market forces' needs and aspirations? Freedom or slavery? Equality or inequality? Competition or cooperation? Love to all or hatred to all? What should be ethical and philosophical foundation of science education? Can creativity, innovativeness and interest in science be increased by creating a few rich centres of science education? Should science be technology savy?

07. QUESTIONS

The deliberations of the Congress will focus on the major questions of concern surrounding the area of science education in India: Has science education truly empowered and united the people of our country or has it increased the divide between the privileged and the underprivileged? Has it strengthened the democratic and secular foundations of our country? Are the institutional structures and practices in our country conducive to innovation and creativity? Have we fragmented and over compartmentalized science education? How can we impart holistic science education and help people comprehend the complex relations between science, technology and society? Do we adopt sound pedagogic techniques for science education? What can we do to arrest the failure and underperformance in mathematics, especially among the underprivileged? What can we do to make the laboratory an integral component of science education? What effect has the new globalization and its attendant market forces made on the nature, scope and goals of science education in our country? What is the nature of the relationship between language and science education? How can we convert the multilingual character of our society into an asset for science learning? How can we enrich science education by giving it a historical and philosophical orientation? What can we do to attract meritorious students towards careers in science and research? Does science education in our country promote creativity? Why is our country lagging behind many other countries in research output, innovations and inventions? Is there any connection/association between science education/education and growing alienation among our scientists/technologists/educated people from society and nature? Many more questions can be added to the list.

08. PRE-AND-POST CONGRESS WORKSHOPS

Peoples Council of Education and Homi Bhabha Centre for Science Education propose to organize a series of pre-and-post Congress local and regional workshops and Conferences on **'Science Education in India'** in order to arouse fresh thinking among the science teachers and scientists and enlist their participation. First Core Group Workshop was held between March 22 and 24, 2007 at Homi Bhabha Centre for Science Education, Mumbai. Its proceedings and papers are available in print as well as on Websites: *http//www.peoplescouncilofeducation.info; http//www.pecindia.info* and www.hbcse.tifr.res.in. Planning of regional workshops at Allahabad, Bangalore, Kolkata, Nagpur, New Delhi and other places is on. Collaborative support from universities and research institutes are being sought. Second Workshop on 'Science Education in India' is scheduled to be held in July, 2008 at New Delhi.

PLENARY THEME PAPERS

ON

SCIENCE EDUCATION IN INDIA

PLANERY I
CONCEPT AND THEORY OF SCIENCE EDUCATION: FORM CURRENT TO NEW

001 BASU, AMITABHA (National Physical Laboratory, **New Delhi- 110012**). THE STUDY AND TEACHING OF THE DEVELOPMENT OF HUMAN REQUIRES AN OBJECTIVE SCIENCETIFIC APPROACH.

The study and teaching of the development of human society are usually carried out under the banner of 'Social Sciences'. By and large, this is done on the basis of collected and compiled data, interpreted as per the views or opinions of certain 'eminent scholars', declared as the 'gospel truth' in textbooks and taught to students. The development of society is often reduced to a series of 'incidents' which some enlightened ruler or noble personality could have turned in a different direction if he/she had been present at that particular place and time. The conclusion drawn is that people cannot be masters of their own destiny, they cannot shape and mould human society in accordance with their needs and aspirations, but can only hope and pray for a hero or a saviour who will lead them out of their present problems and on to a better future. But, are there several possible 'Social Sciences', unlike the rigorously observable and predictable phenomena that are studied and taught in Physics, Chemistry, Botany, etc., each of which is a 'Science' and not 'Sciences' ? In the study of human society, there are few attempts to analyse the data on a strictly scientific basis, on the basis of rigorously verifiable facts and figures, following the same scientific method that is used in the natural and life sciences. But unless we analyse human society on a scientific basis, study the changes and development of society as a scientific process with definite underlying forces and catalysts operating under specific conditions, we will be unable to understand the process of development of society or to predict in what directions society can proceed in the future, depending on the roles played by various social classes. The fact is that there have been serious studies and analyses of human society and its dynamics carried out on an objective and scientific basis, based on dialectical and historical materialism. But the general practice is to dismiss these studies as biased dogmas, partisan political views, etc. We need to study these analyses on an objective and unbiased basis and try to draw conclusions as to what the future society can be, what can be the roles played by various social classes, how these will shape future society, etc. Young minds in schools and colleges should also be taught Social Science accordingly, because they are the ones who are going to build and shape the future human society.

1. Introduction

Under the banner of 'Social Sciences', the development of human society is studied largely on the basis of certain data that has been collected, compiled and interpreted according to the views or opinions of 'eminent scholars', whose pronouncements are declared as the 'gospel truth' in textbooks and taught to students. The development of human society is often regarded as the consequence of the preaching and actions of some ruler or personality, and that if some noble or enlightened mind (or some evil and bigoted mind) had been present at that particular place and time, he/she could have turned the course of human society in a different direction, for the better (or for worse). The conclusion drawn is that the ordinary people themselves cannot be masters of their own destiny, they cannot shape and mould human society in accordance with their needs and aspirations, but can only hope and pray for a hero or a saviour who will lead them out of their present problems and on to a better future. In the study of human society, there are few attempts to analyse the data on a strictly scientific basis, on the basis of rigorously verifiable facts and figures, following the same scientific method that is used in the natural and life sciences. But unless we analyse human society on a scientific basis, study the changes and development of society as a scientific process with definite underlying forces and catalysts operating under specific conditions, we will be unable to understand the process of development of society or to predict in what directions society can proceed in the future, depending on the roles played by various social classes.

Are there several possible 'Social Sciences', unlike the rigorously observable and predictable phenomena that are studied and taught in Physics, Chemistry, Botany, etc., each of which is a 'Science' and not 'Sciences' ? It should be noted that serious studies and analyses of human society and its dynamics have been carried out on an objective and scientific basis, based on dialectical and historical materialism. But a large number of our learned 'social scientists' tend to dismiss these studies as biased dogmas, partisan political views, etc. These analyses need to be examined and debated on an objective and unbiased basis, and conclusions should be drawn as to what future human society can be, what can be the roles played by various social classes, how these will shape future society, etc.

There is broad agreement that the natural and life sciences should be taught in schools and colleges on the basis of live demonstrations, experiments, projects, analyses of data, discussions, etc. and not as some dry 'gospel truths' repeated ad nauseum year after year. It is only then that young minds will be stimulated to critically enquire, experiment, innovate and thereby take forward the development of science and technology in our country. Is not the same thing true for Social Science ? Young minds in schools and colleges should be taught Social Science also in the same manner, because they are the ones who are going to build and shape the future human society in our country.

2. Scientific method for study and teaching of human social development

How should we study the development of human society from early prehistoric times down to the present day ? It may be said that every child in school has been taught these things from the lower classes for many centuries, and so what is the different approach that is being advocated here ? What we are proposing here is not something new, it has been advocated and sought to be implemented in many places at different times in the past. What we wish to reiterate here is that the manner and approach generally used while teaching the development of human society is to inform young minds that human beings conducted their affairs in such and such a manner at such and such a period of human history, as evidenced from written or pictorial records, etc. Very often, when students ask as to why humans in some historical period did not think of doing something in the way that we do it at present, they are simply told that they did not know any better, and that we have learnt from their experience and are therefore wiser. But is this not a subjective excuse rather than a real objective reason ? **Why** does human society conduct itself the way it does at a certain historical period in a certain area of the globe ? This basic question is not addressed, or addressed only superficially.

In physics, for example, there is an underlying reason why an object falls towards the earth's surface – the force of gravitational attraction between the object and the earth. Similarly, the underlying reason why human society conducts itself in a certain manner is the nature of the forces and mechanism of production of the material goods that humans need in that historical epoch, and the mutual relations among different sections of society that are engaged in this production process. Man is a social being, and his/her position in the production process determines his/her social relations with other members of society and also moulds his consciousness and sense of values. This is what historical materialism advocates, and there is no dearth of evidence from the history of human society to support the validity of this analytical approach to the study of human society. Of course, it is not true that human consciousness always follows, and lags behind, the development of the productive forces in human society. The two are intimately linked to each other, and one can influence the other. There is a dialectical relationship between them. Whereas dialectical and historical materialism may sound like a highly philosophical and abstruse subject that children in schools cannot be taught, there are simple ways, by examples, of explaining the underlying basic ideas and showing how the development of human society can be satisfactorily explained by this method of analysis. Moreover, in the natural and life sciences we are always searching for comprehensive laws or principles that can explain a variety of phenomena, rather than trying to postulate laws to explain each phenomenon separately. Dialectical and historical materialism provides a framework to not only understand the historical course of evolution of human society but also to draw conclusions about the future trends in the development of human society and the social forces that can play vital roles in shaping them.

3. Some aspects of social development

3.1. The human family

The human family is perhaps the most fundamental unit of society. Most of us are born into families, with father, mother, brothers and sisters. But how many of us question as to how this unit called the family came into existence ? Has it existed from time immemorial ? Is it some divine law (God's will ?) that stipulates that all human beings should live and procreate in a family unit ? However, the human family unit as we know it today did not exist in earlier times, and has evolved into its present form in male-dominated patriarchal society. Further, while the family is supposed to be sacrosanct for the females in modern society, the males are often excused for straying outside its domain, and polygamy is also sanctioned in some sections of society. Moreover, the consanguine family (marriage between close relations) is permitted in some sections of our society and frowned upon in others, and this too has its history in the course of development of human society. It is essential that we study and teach the evolution of the human family in a logical and scientific manner, showing how it is connected with the forces and relations of production in society and has changed according to them, recognize the hypocrisy and unequal relations between the man and woman in the present-day human family structure and subsequently discuss what the family structure and family relations should be in a future egalitarian society.

3.2. Private property

We are generally told that human beings are inherently selfish, each wanting to grab as much as possible for himself or herself, and that nothing can change this basic human instinct which has existed from time immemorial. Thus the tendency to acquire and expand private property is something inherent in humans. The only way to check this basic instinct is to become religious, self-sacrificing, spiritual, etc., which only a few humans become, and so until the time that the vast majority of humans adopt these traits, human society will have to suffer the consequences of this basic human instinct of selfishness. Further, unless a person is given a material incentive he/she will never work to the best of his/her ability. It is true that we see examples of this human selfishness all around us today. But do we ever raise the question as to whether this aspect of human nature has always existed from ancient times, or if not everywhere or at all times, then how and when did this tendency arise in human society ? It is an established fact that in ancient human society, private property was unknown and everything was held in common for the use of all members of society. Is it possible to eliminate this feature of human nature by abolishing private property in a future society that has developed to a much higher level than ancient society ? These are all issues that should be studied and taught in an objective and scientific manner, rather than delivered to students as moral injunctions.

3.3. The State in human society

Did human society always have a State, an organization of their fellow humans which governs the domain, lays down laws and regulations for the general populace to abide by, enforces these laws and punishes the law-breakers ? Ancient human society did not have, or need to have, a State to govern it, since society was self-governing and self-regulating, with each member aware of and abiding by his/her rights and responsibilities. As society grew larger and became more complex, with division of labour among the populace to perform the various tasks required for society, the need for a governing body to organize the affairs of society was felt, but the body was headed by senior members who enjoyed the regard and trust of the entire populace by virtue of their integrity, honesty and impartiality. However, as the division of labour in society led to the development of private property, i.e. concentration of extra wealth in a few hands, the State came up as an organization of the richer sections of society to control the poorer sections and safeguard their dominant position in society. Sometimes the State was an oligarchy like a monarchy, sometimes a dictatorship, sometimes a democracy, and so on. The form of the State was the one best suited to the requirements of the rulers or ruling classes of society. These features of the State should be studied and taught in an objective and scientific manner : what the economic conditions of society were at a certain

time, which were the dominant sections controlling the wealth of society, what form of the State was preferred by them and why, and so on. Only then will we have a logical and coherent understanding about the evolution of the State, why and how a particular form arose at a certain time in a certain place, why and how it changed eventually, what new form replaced it and why, etc. And finally the question can be addressed – Can the State eventually disappear ? If so, when and how will this happen ?

3.4. Social classes in human society

It is an established fact that modern human society, anywhere in the world, is divided into various social classes. The economic status, the social standing, etc. is different for each class. Ancient human society was perhaps a classless society. But with the coming into being of the division of labour and unequal appropriation of the fruits of labour in society, social classes arose. The evolution of social classes, why and how they arose, and so on, should also be studied and taught in a logical and scientific manner, stressing the underlying reasons – economic, social, etc. - for their rise and fall.

3.5. The future of human society

If the past history and evolution of human society are studied and taught in a logical and scientific manner, as has been suggested above, both the teacher and the taught can have logical, scientific and therefore meaningful discussions about the future developments of human society, what possible directions it can take, what the roles of various social classes can be to shape the future society, how this society will govern and regulate itself, can one expect the development of a classless society (same in name only but quite different in form and content in a highly developed society than it was in ancient primitive society), and so on. These discussions can result in concrete action and movements to develop human society to a higher plane and lead it to a better future.

4. Conclusion

Social Science should be studied and taught in a different way from the generally followed patterns today. The approach should be strictly objective, scientific and logical, just like the approach followed in the study and teaching of the natural and life sciences – Physics, Chemistry, Botany, Zoology, etc. Only then can the development of human society from ancient times to the present day be understood in a logical and scientific manner, and the underlying causes and laws of development can be formulated and understood. And thereafter, logical and scientific conclusions can be drawn about the future course of development of human society.

002 SAU, RANJIT (8/2A, Alipore Park Road, Sonali Flat **2** DKolkata 700027). THE SCIENCE OF SCIENCE EDUCATION IN INDIA.

Universities in the West find enrolment of their 'own' (non-foreign) students in science and engineering courses disappointing. A similar trend is appearing in India's academic institutions as well. The phenomenon of students' indifference to science and engineering is apparently contrary to the Aristotelian Principle which says that, inter alia, human beings by nature prefer doing more complex and intricate activities, ceteris paribus. This puzzle is resolved in this essay citing the works of Ibn Khaldun, a fourteenth-century Arab scholar.

Economists have recently discovered and modeled a branch of the economy that provides sustenance to continuing growth ad infinitum. That life-line of the economy is science and technology (S&T). In overall market equilibrium, the S&T branch, it transpires, employs too little human resources. This theorem invites, by implication, government's financial and regulative measures to break the vicious circle of low employment in the S&T branch and consequently slow rate of economic growth.
Advances in science are not made by impersonal forces, but by living men and women. Their lives and livelihoods, their motives, their relations with social, political and economic landscapes of the time, have

all to be considered. The most important and fruitful periods of scientific advance were those in which social barrier was at least partly broken down, and the practical and the learned men mixed on equal terms. The people liberated from bondage of one kind or another had brought fresh insight and confidence. Such were the conditions in early Renaissance in Italy, in France of the 1789 Revolution, in America at the end of the nineteenth century.

I. Human Nature: Aristotelian Principle

The Second Peoples Education Congress on Science Education in India (2008) is intended to 'discover, develop, and disseminate a new *democratic* system of education capable of flowering *creative potentialities* of particularly the *children and the youth*.' We shall begin with a three-part postulate on human nature --- a basic principle of motivation, known as the Aristotelian Principle.[1] First, human beings take more pleasure in doing something as they become more proficient at it, and of two activities they do equally well, they prefer the one calling on a *larger repertoire of more intricate* and subtle discrimination. For example, algebra is more intricate than elementary arithmetic. The principle says that someone who can do both, generally would rather study algebra than arithmetic.

Presumably, complex activities are more enjoyable because they satisfy the desire for variety and novelty of experience, and leave room for feats of ingenuity and invention. They also evoke the pleasures of anticipation and surprise. And often the overall form of an intricate activity, its structural development, is fascinating and beautiful. Moreover, simpler activities exclude the possibilities of individual style and personal expression which complex permit or even require: otherwise how could everyone do them in the same way?

Second, *changes* in the pattern of desire. As a person's capacities increase over time and as he learns how to exercise them, he will come to prefer more complex activities.

Third, as we *witness* the exercise of well-trained activities by others, these displays always arouse a desire that we shall be able to do the same thing ourselves.

II. Scientists, Engineers, Artisans

Given the context, making a distinction between science on the one hand and technology (or technique) on the other would be useful. 'A technique is an individually acquired and socially secured way of doing something; a science is a way of understanding how to do it better.'[2] Technology is an application of science for producing a certain effect. Science is something recorded and transmitted in books and papers, as distinct from the passing on from hand to hand by practical example of the traditional crafts. As such, from the start, science was an occupation limited to the upper classes or to a minority of gifted individuals, who did not themselves feel the practical needs of life. Advances in science are not made by impersonal forces, but by living men and women. Their lives and livelihoods, their motives, their relations with social, political and economic movements of the time, had all to be considered. The most important and fruitful periods of *scientific advance* were those in which social barrier was at least partially broken down, and the practical and the learned men mixed on equal terms. The people liberated from bondage had brought fresh insight and confidence. Such were the conditions in early Renaissance Italy, in France of the 1789 Revolution, in America at the end of the nineteenth century.[3]

Most *technical advances* are responses to social-economic demands, made entirely in early times and sometimes even now, by the craftsmen themselves working over and improving their traditional skills. Sailors knew very well how to use oars, and merchants to use balances, many centuries before Archimedes discovered the formal law of the lever; but his law enabled new mechanical inventions to be made which could never have occurred to practical men.

Science and technology (technique) had long traveled along separate paths. Technology had always to advance on a front broad as the whole pattern of contemporary life. Nearly all the set of inventions, mostly Chinese, which were to change medieval into modern economy --- the horse-collar, stern-post rudder, trip-hammer, and mechanically driven bellows --- owes nothing to science. Even spectacles, gunpowder, and printing are largely practical achievements, though the inspiration must have come from the learned scientists. Only in the compass and the clock, essential for navigation, does the scientist seem to have made a larger contribution.

In Britain, the first industrial growth --- that of the sixteenth century --- was almost entirely the fruit of the skill of workmen. Two centuries later, the Industrial Revolution (1780-1840) would owe no less to the common workmen. The technological problems at the early stage of the revolution were fairy simple. They required no class of men with specialized scientific qualifications, but merely a sufficiency of men with ordinary literacy, familiarity with simple mechanical devices and the working of metals, practical experience and initiative. The centuries since 1500 had certainly produced such a supply. Most of the new technical inventions and productive establishments could be started economically on a small scale, and expanded piecemeal by successive addition. That is to say, they required little initial investment, and their expansion could be financed out of accumulated profits. Industrial development was within the capacities of a multiplicity of small entrepreneurs and skilled traditional artisans. Such advantages would no longer be available to a country after the nineteenth century.[4]

Thomas Alva Edison (1847-1931), the inventor whose work in electricity, telegraphy, moving pictures, and sound recording was to help lay the foundations of modern electrical and electronic industries, would mark the end of the era of inventor, and the beginning of a new one --- that of directed science in industry. From now on the paths of industry and science will be as closely mingled as they were before the dawn of civilization.

Derived from above, three tentative statements are as follows: (a) periods of scientific advance had coincided with those of social reforms; (b) technological achievements had responded to prevailing socio-economic demands; and (c) common people with ordinary literacy, familiarity with simple mechanical devices, and some experience had contributed immensely to industrial progress in Europe. India's social structure, as it is, had remained essentially unchanged through millennia. What had been the practice of science and technology in India?

India has a long tradition of science. Certainly not less than 2,000 years before the birth of Copernicus, the *Aitareya Brahmana* had anticipated the solar system. It said: 'The sun never sets nor rises. When people think to themselves the sun is setting, he only changes about after reaching the end of the day, and makes night below, and day to what is on the other side. Then when people think he rises in the morning, he only shifts himself about after reaching the end of the night, and makes day below, and right to what is on the other side. In fact, he never does set at all.'[6] From the beginning of the Vedic era in 1500 BC to the close of the Gupta period (300 AD to 500 AD) --- this stretch of two millennia was the golden age of India's scientific achievement. Since then, the period of one-and-a-half millennia (from 500 AD) was relatively dark.

The foundations of modern arithmetic and algebra were laid in ancient India by Baudhayana (8^{th} century BC), Apastama, and Katyayana (5^{th} century BC). Invention of the celebrated place-value number-system, on the eve of the first millennium, was another landmark.[7] Dantzig is puzzled why the great mathematicians of Greece did not tumble of this discovery. 'Is it that the Greeks had such a marked contempt for applied science, leaving even the instruction of their children to slaves?', wonders Dantzig.. 'But if so, how is it that the nation [Greece} that gave us geometry and carried this science so far did not create even a rudimentary algebra? Is it not equally strange that algebra also originated in India, and at about the same time that positional numeration did?' Jawaharlal Nehru responds: We must assume that these momentous inventions were not just due to the momentary illumination of an erratic genius, much in advance of his time, but that they were essentially the product of the social milieu and that they answered some insistent demand of the time. It seems clear that the demand was there, for the Sanskrit books on mathematics wee full of problems of trade and social relationships involving complicated transactions. There were problems dealing with taxation, debt, and interest; problems of partnership, barter and exchange, and the calculation of the fineness of gold. In short, the vibrant economy and society had demanded answers to the questions people had faced.[8] The florescence of science in the courts of Gupta emperor, adorned by Aryabhatta, was the last flicker before the end.

A second issue is: why did scientific advance in India slow down as it did in the next one-and-a-half millennia? Extending the line of explanation offered by Nehru for the preceding golden age, the answer for the subsequent darkness might be interpreted as the shadow of social and economic decay in the country.

Third, why had India's scoreboard of technology had been so unimpressive, compared with China's? Social injunction against job mobility accounted for the lack of technological innovation by artisans; social distance between upper and lower classes, i.e. between the head and the hand, added to the misery.

Now, coming from far behind China and India, how could Europe surge ahead of both in science and technology? The critical period was the Renaissance, and the revolutionary scientist was Galileo (1564-1642) who combined experimental and mechanical skill with the power of embodying his results in mathematical formula. The study of dynamics, i.e. laws governing the movement of bodies virtually begins with him, allowing the application of mathematical hypotheses to nature. Moreover, West Europe's geography of more rugged terrain and no unifying rivers, unlike in China or India, allowed the rise of multiple states, competition between different political entities, spurring innovation.[9] 'As regards the natural sciences, there could be no question that they were strictly pan-European from the time of their first success. It is difficult to give any nation in Europe the credit for this discovery or that, because so many of them were the result of work that was going on everywhere at once, in a series of stages that successively involved all the scientists in Europe.'[10]

After four centuries of hectic engagement with the science of nature, scientists seem waning their enthusiasm. In the West, universities have fewer numbers of Western students in science classrooms; foreigners are numerically larger. Youths in the West have begun displaying lesser tendency towards the study of mathematics, science, and engineering. Their indifference is a matter of concern for a country like India as well. But why are the youths turning away in the first place?

A clue to the puzzle might be found in the writings of fourteenth-century Arab scholar Ibn Khaldun (1332-1406). Rise and fall of Muslim kingdoms has suggested to Khaldun that dynasties have a normal lifespan much like the individuals.[11] A dynasty does not as a rule extend beyond three generations. The first generation, with all the optimism of a beginner, works hard and achieves result. The second generation relishes the vanity of wealth and indulges in luxury. The third generation has little aspiration for fame and glory; given to a life of prosperity and ease its luxury reaches the peak, bringing down the dynasty. By analogy, so it happens to a country as well. At the beginning, the people build their nation with great effort and sacrifice. The subsequent generations enjoy the privilege of inherited facilities and strain themselves less and less for further advancement of the nation.

Now science has a long history of magnificent inventions. It is a relatively difficult subject to study; its pursuit is expensive, time consuming, and somewhat unpredictable. Students might be hesitant to take the risk. To extend the analogy to the case of science study, doesn't it indicate that students from rich families (like those in the West) might move away from sciences and gravitate towards less demanding fields? By the same token, doesn't it follow that children from relatively poor families, charged with high ambitions, would have greater inclination to take up science studies, given adequate assurance of financial support?

III. An Old Subject: A New Discovery

No country in the modern world has ever attained sustained economic growth without having established first a strong base of manufacturing industries. India is, it seems, trying to skip the stage of industrialization and leap into that of service providers: an elitist approach. Millions of artisans in cottage and small-scale enterprises are burdened with obsolete technology and are increasingly vulnerable to cheap imports. The ongoing course of economic growth would impoverish them. India's science had been top-heavy and indifferent to common man. Consumerism has gripped the country much ahead of industrialism.

Economics is an old subject, traceable back to Chanakya (Kautilya), author of the *Arthashastra* (Science of Wealth), in fourth century, BC. Modern economics was inaugurated in 1776 by Adam Smith with his magnum opus, *Wealth of Nations*.[12] Smith emphasized the gain of productivity growth that could be achieved through division of labour in a factory, by workers specializing on narrow tasks. Employees would produce far more than they could if each worked independently. In a pin factory, in Smith's classic example, one person working independently can make one pin a day. But if the job is divided into 20 parts, where one man draws out the wire, another straightens it; a third cuts it; a fourth points it; and so on; 20 persons would produce 400 pins, that is, 20 pins per person. So the book, *Wealth of Nations*, opens with the statement: 'The greatest improvement in the productive powers of labour, and the greatest part of the skill [and] dexterity, ... seem to have been the effects of division of labour.'

Should the division of labour and specialization of workers be the prime source of labour productivity, the company that sets up shop first could compete out all newcomers, by means of increasing the division of labour. So the size of the company is unlimited. To address that indeterminacy, economics introduced an axiom known as the Law of Diminishing Returns: Increase of one input, ceteris paribus, would increase output eventually at *diminishing* rates. It implies that the economy would ultimately reach a

peak, i.e. the stationary state. The assumption of the law of diminishing returns gave economics only a momentary respite.

In 1957, Robert Solow of the Massachusetts Institute of Technology (MIT) estimated that as much as 85 percent of American economic growth over about a century was due to what he called 'technological progress' leaving only 15 percent of the growth for increase in capital and labour to account for.[13] Economics, however, could not explain what constitutes technological progress; it took technological progress as an exogenous parameter. Finally, in 1990, a path-breaking article by Paul Romer of Stanford University discovered and modeled the secret of that limitless fountainhead which is capable of sustaining economic growth for ever within the framework of market capitalism.[14] That provenience is contained within the economy; it is nothing other than a branch of the economy which functions in accordance with the laws of markets.

The economy has three branches, of which the most visible is the one that produces consumer goods (food, clothing, cars); next is the branch that makes capital goods, namely, machine, equipment, tools. Almost invisible to outsiders is the third one that generates science and technology (S&T). For simplicity, imagine that the S&T creates only ideas such as $E = mc^2$. A peculiar property of ideas is that any number of persons can use them without disturbing or depleting anyone.[15]

All products in the economy can be classified into two categories: *rival*, and *nonrival*. Rival goods are those whose benefits are enjoyed by their purchaser --- food, clothing, housing, cars, and so on. Nonrival goods are those that are available to all and without mutual interference --- national defense, algebra, Newton's three laws of motion and the universal law of gravitation. Knowledge or idea is a nonrival good. A nonrival good could be anything whose content lends itself to copying. Products of the S&T sector are essentially knowledge --- mostly nonrival, in the absence of patent. That is why private investment in S&T is scarce; and as a result job opportunities in that branch are limited. On the other hand, the fact is that sustained economic growth calls for vibrant S&T activities. Government could in principle break this logjam with appropriate financial and regulatory measures, and in that case economic dynamics would be self-sustaining: S&T would contribute to economic growth which in turn would feed back into the S&T. The ingenuity of Romer's model is that it makes S&T an *endogenous* variable that obeys market discipline and under certain conditions sustains continuous economic growth. It has thus identified the self-propelling engine of growth. For economics, it's a new discovery.

But how do we induce the students to study science subjects in the first place? One of the fundamental principles of modern scientific method is that nature is amenable to human comprehension.[16] This principle exalts human dignity and capability; it instills confidence among the students. We have to inculcate this spirit right from the beginning among all children regardless of caste, creed, and other extraneous inhibitions.

IV. Thought: A Thinking-Computer

Brain, mind, and thought, these three terms are not synonyms. Brain is a piece of matter: matter is convertible into energy and vice versa. Mind is not a matter as it involves neither matter nor energy. 'Sensations or thoughts do not belong to the 'world of energy'; they cannot produce any change in this world of energy.'[17] Thought or thinking is a function of mind. Brain provides the mind with certain organizing principles and parameters: both are genetic endowments. We know that computers are structured in the image of human mind. For the moment, let us view also the *process of thinking* in analogy with a computer.[18] Let us imagine that thinking is done by means of an assembled 'hardware' and 'software', as it is in the case of a computer. Hardware of the thinking-process-computer (thinking-hardware, in short) is constituted mostly during childhood and adolescence within the environment of family, school and college. The term thinking-hardware does not refer to any physical part of the brain like tissues or nerves; this hardware is ethereal, impalpable, consisting of a store of certain information as elaborated below. Since 18 is the minimum age for the right to vote or to join army in many countries one might say that by that time the making of thinking-hardware is completed, pending periodic updating. And software is installed in the thinking-computer throughout one's life, e.g. by learning algebra or climbing mountains.

The thinking-hardware is made of two kinds of ingredients, namely, (i) on the one hand, a set of discrete, *a priori* concepts such as time, space, quantity, quality, and reality, and (ii) on the other, certain statements relating to, for example, the emergence of the universe, the purpose of human life, and the nature of time. We shall see in a moment that in the construction of thinking-hardware religious faith

occupies a vital place.

An ingredient of thinking-hardware may have several alternative connotations. To begin with, take the case of 'time'. To physicists, there are three concepts of time, namely, thermodynamic, psychological, and cosmological.[19] The increase of disorder or entropy with time is one example of what is called an arrow of time, something that distinguishes the past from the future, giving a direction of time. There are at least three arrows of time. First, there is the thermodynamic arrow of time, the arrow of time in which disorder or entropy increases. Then, there is the psychological arrow of time. This is the direction in which we feel time passes, the direction in which we remember the past but not the future. Finally, there is the cosmological arrow of time. This is the direction of time in which the universe is expanding rather than contracting. Under certain assumptions (viz. the no boundary condition for the universe, together with the weak anthropic principle) one can explain why all three arrows point in the same direction --- and moreover, why a well-defined arrow of time should exist at all.

The psychological or historical arrow of time, by which we feel the passage of time and remember the past but not the future, comes in three varieties: cyclical, regressive, and progressive.. To some people, the course of time is cyclical --- four epochs (*yuga*), viz. satya, treta, dwapar, and kali, repeating in that order in an endless horizontal series of cycles, without any upward trend of progress in any sense. To some other people, time is regressive: over time people tend to become less and less religious in their commitment to faith and piety. It would be the singular duty of reason to refurbish their submission to religion continuously so that the depth of devotion remains constant. There is a third group of people to whom time is progressive: humans, among all creatures on earth, are blessed with the privilege of having company of the Holy Spirit who leads them over time towards ever greater glory of the Lord. A person's thoughts will be coloured according to the conception of time he or she incorporates in thinking-hardware. As for its consequence, belief in the cyclical variant of time is likely to make the person stoic who suffers without complaining, while the regressive one would cause anxiety or pessimism, and finally the progressive one would radiate optimism and a dynamic attitude towards life.

For another example, consider the origin of humans. Darwin and Wallace ascribe human's appearance on earth to the evolution of living organisms of nature, a physical activity. By contrast, almost all religions believe in Creation by divine authority. Again, one's worldview would be sensitive to the choice from this menu of two. The Darwin-Wallace idea tends to make humans feel humble enough to acknowledge themselves as part of nature, chimpanzee being their nearest biological cousin. The other one, by contrast, would imply that humans are the purpose of the universe, thereby making them arrogant vis-à-vis other creatures and nature in general. There is one more dimension to the theological doctrine of Creation. Hinduism speaks of the creation of four categories of humans --- brahman, kshatriya, vaisya, sudra, in that order of social hierarchy. In all other faiths, one kind of human being was created, from which came the descendents; all human beings, therefore, are equal in social standing. Clearly, a person's thought and belief would be shaped by the doctrine put in his or her thinking-hardware.

V. Science Begins at Home

Affluence leads to excessive luxury (remember Ibn Khaldun) and saps individual initiative. In the rich West, students, raised in comfort and ease, may prefer staying away from science and engineering, apparently in defiance of the Aristotelian Principle. A similar shadow has fallen on India: enrolment in science courses is below the mark. Should the children of families with relatively modest means exhibit greater enthusiasm, they should be given assurance of adequate financial support during their study and job in S&T sector, conditional upon the student's demonstrated competence.

Human society formally bears comparison with the universe. In the limitless space of universe, celestial bodies --- planets, stars, galaxies --- orbit in paths that can be comprehended with Newton's law of universal gravitation: Every object in the universe attracts every other object with a force, directed along the line of centres of the two objects, that is proportional to the product of their masses and inversely proportional to the square of the separation between the two objects. Similarly, we conjecture, do humans in society attract one another, and thereby determine their orbits in society.

Newton's law of gravity has been applied to explain inter-regional trade. In a pure gravity motel trade between two countries is taken as proportional to the gross domestic product (GDP) of respective countries (in analogy to the respective 'mass' in the original theory) and inversely proportional to the square of the distance between them. For a model of social gravitation, it will be necessary to give similar

foundational form to the benefits of interaction between individuals at different locations in social space. A natural interpretation of the mass in this context would be, say, educational achievements. With this procedure, Newton's gravity model, with marginal modification, has been found capable of explaining such social features as the existence of stable social classes, subcultures, or linguistic dialects.[16]

Philanthropists and social activists have acted for integration of isolated groups into the general society. Confirming the gravity model, it transpires that when several members of a group are induced to *expect* all others to follow suit, they would go for the intended change. But, if only a limited few are persuaded towards a desired direction, while they *expect* others not to follow suit, the project would fail. In the present context, it implies that sufficient numbers of students have to be brought under the scheme of science studies. Once the project is under way, and some students show signs of significant success, other students also might be attracted to it, in accordance with the Aristotelian Principle cited above.

A student's school life is an extension of his or her family environment. With the mode of economic production undergoing changes, innumerable peasants and artisans are getting uprooted from their livelihoods. To salvage the family children are being drawn into some odd jobs. For science to prosper and thereby the economy to have sustained growth, children of modest wherewithal have to be rescued from premature obsolescence.

Notes

1. John Rawls, *A Theory of Justice*, Harvard University Press, 1999, at 372-80.
2. John D. Bernal, *Science in History*, 3rd ed., Penguin, 1965, at 47-51, 1220-30.
3. Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 3rd ed., University of Chicago Press, 1996; idem, *The Road since Structure*, ed. James Conant and John Haugeland, University of Chicago Press, 2000.
4. E. J. Hobsbawm, *The Pelican Economic History of Britain*, vol. 3, Penguin, 1968, at 39.
5. The 'Bengal Renaissance' had left behind little imprint on the social life of India. Susobhan Sarkar, *Bengal Renaissance and Other Essays*, Peoples Publishing House, 1970.
6. Sarvepalli Radhakrishnan, *Indian Philosophy*, vol. 1, Indian edition, London: Macmillan, 1951, at 29.
7. Here is a contrary view: 'decimal place value and a blank space for the zero had begun in the land of the Yellow River earlier than anywhere else. And a decimal metrology had gone with it.' Joseph Needham, *Science in Traditional China*, Harvard University Press, 1981, at 10.
8. Jawaharlal Nehru, *The Discovery of India*, Oxford University Press, 1982, at 216-21; S. Radhakrishnan (chairman, editorial board), *History of Philosophy: Eastern and Western*, vol. 1, Allen & Unwin, 1952, at 431-71. According to Nehru, 'The earliest use of the zero symbol [in India], so far discovered, is in one of the scriptural books dated about 200 BC.' In Needham's account, the zero symbol was first used in China in the first century BC, which makes it one century later than in India, not earlier.
9. Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Society*, Norton, 1997, at 405-34.
10. For example, 'Johann Kepler (1571-1630) belonged to a virtual family of kindred spirits --- his predecessors (above all, Copernicus), his contemporaries (above all, Galileo), and his disciples. If we were to mark on a map their birthplaces and the centres where they worked, the whole of Europe would be covered with black dots. Medicine, biology, and chemistry showed a similar pattern. None of the sciences can be described as having been German, British, French, Italian or Polish, even for a short time. They were always European.' Fernand Braudel, *A History of Civilizations*, translated by Richard Mayne, Penguin, 1993, at 404-05.
11. Ibn Khaldun, *The Muqaddimah: An Introduction to History*, Princeton University Press, 2005, at 136-38.
12. Adam Smith (1776), *An Inquiry into the Nature and Causes of the Wealth of Nations*, Oxford University Press, 1976.
13. Robert Solow, 'Technical Change and Aggregate Production Function' *Quarterly Journal of Economics and Statistics*, 1957. Solow estimated the following equation: $Y = A(t)F(K,L)$, where Y is national income, K capital, L labour, A is the parameter representing the level of technology, t being an indicator of time.
14. Paul Romer, 'Endogenous Technological Change,' *Journal of Political Economy*, 1990.
15. David Warsh, *Knowledge and the Wealth of Nations: A Story of Economic Discovery*, Norton, 2006, at 282-304.
16. Irwin Schrodinger, *What is Life*? with *Mind and Matter*, Cambridge University Press, 1958, at 117.

The Upanisads had a similar message. 'Nature is the object of a subject, quite rational and thoroughly intelligible, capable of control and worthy of love.' Radhakrishnan, *Indian Philosophy*, vol. 1, at 170.

17. Schrodinger, *Mind and Matter*, at 127.
18. This structure of the thinking-computer is designed after Kant's theory of cognition. The Kantian *a priori* categories are stored in the thinking-hardware and the *a posteriori* experience in the thinking-software. Immanuel Kant (1781), *Critique of Pure Reason*, Cambridge University Press, 1998; Ranjit Sau, 'Science, Democracy, Secularism', presented at the *First Peoples Education Congress: Science Communication*, Indian Academy of Social Sciences, Allahabad, 2005, reprinted in: *On Democracy and Progress*, K. P. Bagchi, 2007, at 143-45.
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003 PITCHAPPAN, R.M. (Department of Immunology, School of Biological Sciences, Madurai Kamaraj University, **MADURAI 625021**). SCIENCE EDUCATION IN INDIA.

India is one of the ancient lands wherein Science was known from ancient times. Starting from the Nalanda University, till our recent self-financing colleges, the massive number of students of this country expected to learn something useful for their life and job. Have they learnt? If so what percentage? Has the social justice, the vision of the Father of the Nation become true? Has our Nationhood fulfilled these aspirations? If not, where does the problem lie.

There have been many policy documents in recent times, on "Meeting the Challenges in Education, Higher Education & R&D". Many Directors of the Islands of Excellence, Vice-Chancellors of Universites, Secretaries of various Funding agencies and the Science Academies put their heads together to develop a policy document to be adopted in the XI Plan. By these measures, and the massive layouts the policy makers expect the scenario to change and some miracle to happen. Will it? Many are also pessimistic on our capability, for lack of machinery that can implement these with a competitive spirit and accountability. Then what can be the best or more suitable model that may salvage the situation?

I propose, similar to 'Lok Adalat', the local 'Elites', individual or a group, in a subject, are entrusted with the responsibility with participatory management and deliver. The most important factors determining the success of Science Education in this country are: (1) appointing teachers with an aptitude for teaching and research, (2) unbiased evaluation and selections without nepotism and political interference (3) salaries and incentives sufficient enough to attract talents (4) a tenured employment that is extendable based on performance and (5) creating an ideal atmosphere to retain the trained talents in the country. I will explain some of these from my experience, how we have achieved Quality in our research. There has to be a Human face in everything: but Nature does not have any courtesy. If we do not rise to the occasion now, the Future generations may not forgive us for the woes we have added to the society.

004 PITCHAPPAN, RM. (Department of Immunology, School of Biological Sciences, Madurai Kamaraj University, **MADURAI 625021**). SCIENCE EDUCATION IN BIOLOGY: THE CURRENT CRISIS & SOLUTIONS.

Michael Wood started his 6 hr, 2007 "Story of India", BBC Documentary asserting
"Sixty years ago, India has thrown out the chains of the British Empire to become a free Nation; and now the world's largest democracy is rushing headlong into the Future. As the brief hey day of the west draws to a close, one of the greatest players in History is raising again".

I wish, we equip ourselves to make the assertion of Michael Wood true!

Yes, the world is watching India and of course China very closely: for their future survival story, in the light of the past success story. While I would agree on the past, would also be optimistic about the future.

Science Education in India

The problems we face currently in the Science Education – Manpower, Infrastructure and Quality are transient. With appropriate remedies it can be set right in the years to come: but lot of dedication on the part of government, community and society is required.

Scientific temper most of the time is an inborn quality: having a mind of inquiry, the person further probe in that direction. The mental frame and calibre of a student is moulded at home, personal experience, but mostly at educational institutions and logic – obtained through life time experience, training and education (formal and informal). Nonetheless, learning science at the class room is different from this innate quality: one is compelled to learn many times. Thus excellence can be anywhere: and it is the purpose of any democratic, civil society to provide an opportunity to any child, to learn and excel: In this direction India has fared better, though not the best: the appallingly poor performance of peripheral and border states particularly in backward tribal areas in this regard seems to have stemmed from the known lacunae in our governance and administrative machinery: my conviction based on my personal observations in these states – thanks to the Genographic project, that made me to travel the length and breadth of the country.

With the world becoming a Global village, it has become obligatory that it is important to keep pace and tract of changes in the field of science as well. A careful observer of our surrounding and observing what is happening around us, a teacher, would hence enlarge his or her knowledge base. Nonetheless, learning Biology comprehensively in formal education leads to better understanding of what we could not observe in the 'world' around us. This has become more so in the Era of Genomics and Bio-technology. These later development became more instrumentation oriented involving innovative ideas – thus patent and rat race sets in!

In the present day formal educational system, a student is expected to learn everything: not that he/ she likes it: this was essentially because the purpose of education has become 'employment' and not the 'knowledge'. This becomes more intense in the context of trying to create and provide jobs and calculate employment or unemployment in a country wherein we have instituted modern governance on the 50 to 30,000 years pre-existing populations of enormous size of one billion: in western and new found world, having instituted governance, people expanded. The land and revenue records created by the British, and families with few hectares of land gets fragmented during the last few to10 generations and the villagers become aimless birds in looking for the opportunities of survival. He or She (90% educated – school / college) is lost without knowing what to do: the spiralling costs of living and labour has lead to further divide between rich and poor: the shadow economy seems to win. Thus education does not give them straight a comfortable life. Each one needs to undergo the drill our ancient man underwent in walking the coast from Africa to Australia! Leave for Urban environ for livelihood. Leave alone all these chronic maladies, my question here in the context of the topic of this conference was, whether our educational institutions deliver a quality 'bread' for the students: If not, where does the problem lie – I will explain this with data and my life time experience (Pitchappan)

Biology – special:

Biology is special in Science Education: I would say Biology is the easiest subject (!) to learn, provided one has a liking for it: I am not sure whether it is imprinted in Genes! Learning through observation is the easiest part in this and Nature provides ample opportunities: Most of the discoveries, Archimedes principle, flight, radar and many innovations were all based on careful observations: I would say the profounder of various religions were also of these categories.

60+ years of Independence:

Where are we after sixty+ years of independence in science education? Can we say it has improved? The probable answer is yes: in spite of deficiencies as revealed by the latest two compendiums from NISTAD and -----. Nonetheless, there are gross discrepancies in Science Education in this country at the grass root level. These can be attributed to many factors: I narrate one after another.

Funds for Science.

As per the NISTAD directory, though the funding for science in India is not at par with the western world, I may not say that the funds were insufficient to do our research and innovation in 90% of the biology subjects, except Genomics and Biotechnology. Here again, I would like to ask a question about the utility of the hard earned and established infrastructures: Massive investments have been made in many institutional R&D facilities: to a certain extent in various identified universities. But in my opinion not even 5% utility or equipment time has been achieved. Various governmental funding agencies tried to do this survey, years ago. Nation expects from these R&D that these institutions are to provide some succour and comfort to the common man. I further restrict my presentation to Universities.

Science Teaching in Universities:

Thrusts have been made on dedicated governmental R&D: strategic institutions such as BARC, SPACE MISSION fared well. In terms of Biology, the scenarios of progress in many of these institutions are not at par with similar western funding agencies. Now the focus is shifting towards universities. 'Ancient' universities are identified and lot of funds for infrastructure and expansion provided: Concept of Deemed universities and self finance universities have taken over the State funded universities: both have similar maladies: state funded ones are many times controlled by local governments being the 'paymasters', while the self finance are infested with 'Western' style, caste based politics and nepotism. Universities have become governmental departments with no intellectual inputs in many parts of the country. The only question is whether they deliver quality goods: whether the students are fit for or equipped for the degree they obtain in these institutions? My emphatic answer is 'NO': Only 5 to 10 percent of the universities and colleges really deliver the purpose of their existence, with full honour and merit.

When we buy a banana or biscuit, where we bargain so much with the street vendor, common man is not prepared / knowledgeable to demand quality in education. It has become impossible in a country, where only collective bargain or wisdom rules the roost, an individual becomes a passive spectator, and somehow every family make their children settle in their life – Junkies to Bollywood!

Antique vs. Modern subjects:

Yet another problem, the country faces in biology is not many present day biology teachers of the colleges and universities know taxonomy, ecology etc., To accommodate more modern subjects such as immunology, genomics, biotechnology etc., many of the ancient and classical papers on taxonomy, developmental biology have been thrown out from many colleges and universities. The craze for Biotechnology stem from the job opportunities opened up by Computers and Information Technologies: but there is absolutely no parallel between these two and the students who have take up biotechnology all have felt bad to worse having joined the course: no teacher to teach, but paid the 'dowry' heavily! I pity for them.

Biotechnology and the 'Loot / Lotto':

It seems Scientific community / policy makers in the country was in a haste in opening up the Pandora's box "biotechnology": Many scholars are of the opinion that the Biotechnology theory and practicing should have been introduced as a post M.Sc., diploma: Now, leave alone the universities: every local college in every state teaches biotechnology at the undergraduate level: why even at high school level. In fact we do not see so often biotechnology departments as such in the western world, including Cambridge or Oxford. Again most of the performing biotechnologists of this country are all from basic plan. When the technologies are made into subjects, and when somebody does not have a strong foundation of a basic subject such as botany, zoology, microbiology their power of utility in biotechnology hangs in air. Their employability, unlike IT sector is very restricted to few pharmaceutical and medical industries. I would say, in the name of Biotechnology, many private teaching institutions have made a big 'loot' of the innocent parents and students alike. This is the right time to make corrections and remedies of the situation to salvage biotechnology education. When a child grows it has to learn one after another; there are specific needs and requirements of the child that he/she learns one by one. Dumping everything together bundled will normally lead to split image: in this case more of 'technicians' than 'intellectuals'.

Infrastructure:

Science has to be taught by the 'Learning through observation' mode. This is what Nuffield and other western curriculum has succeeded. The laboratory training has to be the prime mode of learning science: Many scientists, who returned from abroad joining the University services, inculcated this approach through COSIP and UGC programmes. Now the Academic Staff College of various universities train them for 21 days only in fractured theory classes: the purpose being the promotion of the teachers concerned. This need to be made into 21day practical sessions along with theory, that too in a given subject of the discipline.

Towards this end, the University departments need to be strong in the field of specialization and techniques. In spite of massive funding through extra mural research grants by various governmental funding agencies, the picture is gloomy.

The reason essentially being non availability of maintenance grant and also technicians to operate the costlier equipments, such as Electron microscope. Most of the equipments are not maintained properly and become obsolete in five to ten years time. In any research laboratory, the outcome through new equipment is harnessed in the first few years of time: does it happen? No. Essentially because, these are mostly handled by research students, who are raw masters students with no idea on instrumentation. Not to talk about colleges: even the teachers trained in COSIP and other programmes, do not know to balance a centrifuge and the refrigerator is used to store drinking water and the Head of the department does not allow anybody to use it for research purpose. Under the industrial parlance, an industry is called sick, when the production dwindles below 30% of its capacity. On this scale, most of our Universities are sick: not utilizing the equipments properly, not maintaining them useable, and not allowing fellow workers and students to use the equipments.

No Man's Baby:

Education is a concurrent list: Centre finances infrastructure developments and innovative ideas in the five year plans, while the States need to carry it over, after the plan period. But it never happens for reasons of financial austerity. Further the local governing bodies become important in the growth of the institution that normally interested in carrying out the legacy somehow and not in quality delivery. One of the current major crises is the vacancies in the sanctioned strength of the teaching staff in various university departments: most of the universities have only 20 to 30% of sanctioned strength to carry the burden. Competitive sprit and academic environment lacks in various Universities: not to talk about the quality of the teaching. One of the reasons is, that in spite of the UGC implementing rotation of Headship in the Schools and departments, the collective wisdom does not prevail in sharing the funds available: the rules are broken often and a few always get a lion share. Whenever a new collective project sanctioned to the school as a whole, the power of administering that for ever rests with 'mightier', inspite of the rotation of the Headship. The same is true at the National level. Most of the programmes started with long term visions such as Drosophila centres, Hybridoma facilities etc., all have become a fiasco in many parts of the country, leading to a compromised laboratory experiments. Many vital subjects have been thrown out to accommodate newer ones. Members of various committees of National bodies and Funding agencies do not include younger generationz and intellects: one has to wait for generation change to occur – but that delays the progress by two generations. Sheer nepotism, proximity, familiarity and intellectual armoury to administrative power and funding agencies operate many times. Thus there is very little commitment on the part of many good scholars, to undertake a responsibility in this sullen environment. The days of Krishnaswamy, Muthukkaruppan, Modak, Padmanabans all are only remembered but not practised. All these I call as 'post independence malady' of Science Education. We need to cure them urgently.

Job security:

In this direction, Job security is the prime culprit. Somehow if one has entered into the job, he/she can never be asked to go: rather, time bound and non merit periodic promotions are in vogue. In spite of the fact that NET or CSIR examinations are a requirement for becoming a lecturer, many states have their own SLET and made their own appointments. In a demand supply situation, then most of the state universities are bound to loose the race to self finance institutions: the 80% of the marginalized, rural populations are at loss. The picture of self finance institutions is also not very rosy: many times it is the contract labour that teaches the course: sheer exploitation of the situation. Only a stringent regulation can salvage the situation.

Gate of No Return:

Where does all our Ph.D students from Universities go, once they complete their Ph.Ds in the frontier areas of Life sciences? Most of them, particularly in frontier areas of Life sciences go abroad for Post Doctoral Reseach: Asian and Chinese post docs are cheaper man-power in the Wesetern world to carry out science. Then the question is 'Why do they go?': the reasons are three fold – i) good salary and comfortable life not available in India, ii) better working environment is better and iii) No place (very few places) in India to work. Thus India trains these Manpower at the expense of its exchequer, to export them to developed world: developed world gets trained, honest, sincere manpower with no cost! These people and their lineages do not normally return to India.

Science Education @ Schools:

While the status and quality of science education in the Universities of the country has gone down appreciably, not in commensuration with the development of science in the world, the curriculum development committees headed by these elites have dumped these developments at the High school curriculum itself. Nonetheless, the schools are ill equipped to handle the subjects, particularly the laboratory courses. In terms of infrastructure and practical, the yester year Pre University Course in the colleges delivered better, having the degree teaching laboratory and equipments available in the colleges. Though the problem is not insurmountable, provisions and technologies are not reaching the schools: once again there is a bid rural – urban divide.

Rural Urban Divide

While most of the needy populations live in the rural villages, and sufficient funds are available, the biggest problem is implementation both at school and college level. While many Urban schools (philanthropic) perform better, the government run schools in urban area are also infested with the same problem as that of the rural schools – for lack of facility and commitment of teachers. Unless the rural, government and private schools rise to the occasion it is impossible to think of the Knowledge society.

Social Justice & Immunity

India is one of the few countries that have fared extremely well in rendering social justice to women and under privileged communities and tribal. The post independence efforts in this direction has alleviated poverty and reduced infant mortality appreciably. Nonetheless, the picture was not rosy in terms of education. Even after sixty years of independence there has been only one doctor among the tribals of Nilgiris: not to speak about north eastern tribal belt. Nonetheless, the life and style of the tribal have been uplifted much by the NGO mode of delivery. This is evident in North eastern hill states: In just five year time, 250 students of Apathani tribe have become graduates, a feat that could not be achieved by our governmental agencies with all the money at its disposal. Here stems the dedication and the missionary zeal of the NGOs concerned. Vivekananda Kendra, Don Bosco and other churches have made these great knowledge contribution to the Northern Eastern tribal: no wonder that tribal without religion adopted a religion!

Nonetheless, the social conflicts are not uncommon among the employed teachers/ graduates and scientists of various social tiers through out the country. This stems from the fact that different yard sticks are used in admissions, evaluations and promotions: Many industrial sectors experienced similar hiccups to correct themselves in due course of time. It is essential that while offering this social justice, the quality is not diluted: a mid-course correction is thus required.

SOLUTIONS – MY SUGGESTIONS:

Practicing Science in this country, as well as in the world has become a job: not like the days of Srinivasa Ramanujan, Darwin, Mendel and Aryabhatta. In university set up it has become more of a preaching and not practicing: A thrust and commitment is required on the part of the teachers.

(i) Mission & Industry Mode:

a) Nowadays the Universities are expected to obtain patents on their discoveries and also earn their own resources. Thus Such performing institutions should be encouraged by matching grants as suggested in NISTAD report.

b) A Mission Mode of research is inculcated among the faculties and scientists.

c) Not many grants are given to the same group, institution or scientist.
d) Many funding agencies, funds for similar type of research: Funding agencies thus need to talk to themselves and allocate their portfolios.
e) Funds for Equipments and instruments be provided only for "Common instrumentation facility" as the property of the University and this be administered with mutual trust and transparency. Every requiring scientist shall havie access to the facility: (though this was the concept as on date, no where it is practised).
f) The usage of Instruments be evaluated annually and further sanctions may rely on the utility, performance and output.

(ii) Tenureship and Pay scales

Aptitude to do any work is an important factor in the success of the venture. This seems to be the major problem with 'teachers' as on date: People without any interest or commitment come into teaching profession. This need to be changed. Evaluation need to be perfumed at National level, with automation, thus reducing the chances of manipulation. Online submissions as in the case of public sector and financial reforms and institutions shall be implemented.

a) Evaluate the aptitude of the candidate for teaching: unless they are experts in the field, they cannot pass on the message to others. Thus only the top scorers should be commissioned for teaching profession.
b) Offer Five years Tenure period with a one year probation: The selected teacher at the University level shall be paid a starting salary of Rs.30,000/- + allowances, for the probation period. Found fit at the end of the first year, the rest of the tenure he be designated as Asst. Professor and paid a take home salary of Rs.40,000/-+ allowances.
c) On completion of Five year tenure, his/ her quality of being a teacher and researcher be evaluated: this shall be based on student evaluation, peer evaluation, commitment, hours input, research undertakings & outputs.
d) The second Five year tenure shall be more critical to become a Professor. It shall fetch a 20% hike in the salaries and perks.
e) Only on successfully completing and proving himself / herself, one shall be eligible for a permanent affiliation with a university or a college.

(iii) Evaluation of Performance

Considering the importance of quality, UGC has established the National Accreditation Council, as an autonomous body. Nonetheless, conflicts arise quite often with the institutions and newer strategies and methodologies are being developed. It is essential that a fool proof, evaluation methods – without subjective question and answer, and flexible yardstick and personal and personnel bias be developed and each institution evaluated every years. With the amount of IT skills available in the country, this is possible and can be instituted within an year, at National level.

a) Specific, unambiguous evaluation methodology, using computer coded forms, and online submission be developed to evaluate the performance and progress of the laboratory, school, University, by the teachers, students and stake holders alike.
b) Confidential, student evaluation of teachers, facilities, quality, commitment etc., through online submission be instituted. Students are the best judges of teachers. No good student will call a good teacher a bad one: the contrary may be true.

(iii) Teaching Teachers – 'Crash; Programme:

To salvage the poor performance of Science Education in the country, teaching the available teachers and prospective ones become essential. The promotions of the existing teachers may rest with qualifying in the crash programmes. UGC may undertake the organizational and funding responsibilities:

a) A one month Crash Laboratory courses be organized and imparted to teachers in the universities and colleges.
b) Select Scientists, including retired ones, University departments shall be commissioned to 'Teach the Teachers' in the Universities and Colleges in various regions of India.
c) In turn select Colleges, shall impart two weeks crash laboratory courses in various subjects, to Science teachers of the Schools in respective regions / states.

(iv) PDF Culture:

Under Indian context, most of the Science in universities are carried out only with the Junior or Senior Research Fellows, pre Doctoral scientists. Whereas in the west, it is the technician and post-doctoral based. Post Doctoral Fellows are equipped for carrying out science better: but in India this culture is literally absent for the reasons mentioned above.

a) Each University shall have ten full time or near full time scientists / post-doctoral fellows, to carry out mission mode projects, working under a given faculty in a discipline

b) The working environment and centralized facility be developed

c) The remuneration be equivalent to the lecturers indicated in section II-b of the SOLUTIONS, except that lecturers have teaching responsibility while PDFs full time researchers.

d) Provisions for performing PDFs to be absorbed as Lecturer and vice-versa shall be enshrined in the legal frame work of Science management and Universities.

(iv) Philanthropy:

Following the pattern of 'Lok Adalat', people are interested in the growth of their respective own regions: Hence philanthropy needs to play a crucial role in this transformation. The responsibility of such 'Teaching the teachers' and quality assurance shall be left with the elites and industrialists of respective regions. As on date 80% of the educational institutions are run by the local philanthropists. Hence they should be interested in improving their standard of teaching and science education. Pioneering departments of various universities should come forward to offer these Laboratory courses.

a) Each institution sponsor their teachers for "Quality Upgradation" propgrammes, at their own expenses,

b) UGC identifies the institutions to offer this Quality Upgradation and fund for consumables of such programmes, Manpower, Laboratory Manuals and equipment mainatainance grants.

(the author commits to train Teachers, at Lectuer level from Universities in India, in Immunology, Genetics, Genomics and Statistics & Computers, under this mode)

c) All teachers in University and colleges be trained under this programme, with in three year period.

d) Teaching materials thus developed shall be made available for students to use in their class rooms.

My Mission & My conviction – Cause & Effect of "The Genographic":

I came in for Science out of curiosity to do Science: It is we who maketh the society, I strongly believe. My conviction to write the above paper stem from my success story in Science and in Genographic and also as the Director of Science Education Centre and Education Media Research Centre of our University and also having conducted many science exhibitions for schools including that of Science Congress, and the last but not the least instrigation by Prof. Chaubey.

Living in a milieu of 'competition', from the famous Krishnaswamy school of Biological Sciences, we published in 1991 on the inverse correlation of Mantoux test with serum antibodies in Human Pulmonary tuberculosis disease: This was confirmed in 1992 by two entirely different group one at Brazil and another at Indonesia. Then in collaboration with University of Oxford, described the Genome predisposing for Leprosy: published in Nature Genetics in 2001. This was also confirmed verbatim in Vietnamese cohorts, this time Canadian and French workers. In the era of citation indices, nobody or no science indexing institutions care for such repetitions and confirmations, to our dismay: the scientific world is still a compromised society, I was surprised! It was an incidental work at Oxford that we stumbled on discovering the First Migration of Man from Africa to Australia through the coast of India: that was made into the famous documentary 'Journey of Man' by National Geographic. The first author of this paper, the post-doctoral fellow with Sir Walter Bodmer, was the story teller in the documentary: he could convince National Geographic society to sponsor for a public funded research : the NGS readily agreed and bequeathed 20 million US$s for the project along with IBM and The Ted Wait Family Foundation. When he asked me whether I can do the Indian chapter of this Genographic project in Nov 2004, I thought for a couple of days and said yes: after all everything is science and migration is very much a population genetics, the area akin to what I have been working all through these days in HLA. The Genographic

Laboratory for India, one of the ten in the world and only one of its kind in India, was thus set up at Madurai Kamaraj University at an expense of one Crore rupees. The project is a mission mode one to study 10,000 people from India in five year time, for their mitDNA and NRY chromosomal markers using standardized set of markers that is used in all the ten centres, so that the results are comparable.

What have we achieved since the start of the project in 2006 July?

Yes, 9000 samples from 60% of the India, except central and north western parts: with laboratory analysis completed in 70% of the samples, in just three years of time, with one post doc, three research students and four supporting personnel: The percentage utility of the equipments – ABI Sequencer / Gene Scan – 16 capillary, 384 Taqman real time PCR and two PCR machines have been 90%. This is the model we need in various research projects in India: of course I myself have learnt it only too late, after undertaking the European community and Welcome trust research projects. I submit that our laboratory is thus capable of handling such an exercises mentioned in the SOLUTIONS above. Anybody interested is welcome to visit us.

Now, in India, the technologies are available, expertises are available and no dearth of money. Only we need to re-organize our house: this is the need of the hour.

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005 PRAKASH, BURTE (Maitra, Plot No. 5, Antrolikar Nagar No 3. Behind Kinara Hotel, Hotagi Road **Solapur 413 003, Maharashtra).** OVERCOMING THE CONGNITIVE DISSONANCE IN SCIENCE EDUCATION.

For the last couple of centuries, science and technology became an engine of global development. It has made the world increasingly techno-savvy. As a result, people need to acquire certain scientific and technological skills to earn a good livelihood. The market caters to this 'social need' by conducting different courses in science and technology through schools, colleges, universities and many recognised and unrecognised institutions. The successful persons come out with flying colours and get well paying jobs. Thus, science and technology education does answer the need of earning livelihood. However, the students continue to carry dichotomies, some times throughout life. This paper deals with few areas of science education that suffer from dissonance mainly because of misconceptions, that have origins in every day experience, patterns of human relationships, world of emotions, various arts, aesthetics and religious faiths. Such a situation forces a student to adopt a fragmented life- one a personal life and the other a professional life. The paper also suggests ways to deal with the fragmented science education as well as life itself by stressing the need to redraw a holistic science curriculum.

Introduction:

A comparison of global situation in last few hundred years shows that unprecedented material development has taken place throughout the world mainly because of science. The list of developmental indicators is quite large. Suffice to sight few examples: increase in human lifespan because of medicines, coping with increased global population due to higher agricultural production, many fold rise in the literacy and shrinking the world because of fast transport and efficient communication. This is despite the large-scale human and material destruction due to wars with the weapons of high potency and despite the wasteful consumption due to alluring markets. Naturally, science and technology and science education has acquired tremendous importance. However, the purpose of science education cannot be only to produce the next generation of scientists. Today we face issues on a global scale that are fundamentally complex and technical in nature. Climate change, balance between energy resources and its consumption, food production, fall in forest covers, wars and their effects, are just a few of the examples. The resolution of such complex and technical issues demand wise decisions based upon basic scientific literacy and wisdom. Unfortunately, both the scientific literacy and wisdom necessary to take decisions in the interest of

common people are not genetic in nature. Each generation of students has to internalise them through quality education.

Let us not forget that teaching and learning science is a human activity, embedded in and influenced by society and culture in which both teacher and student grow. As a result, the socio-cultural interactive processes shape how students learn and understand science. All cultures have well developed theories about how the physical world operates, even though incorrect in the eyes of science. As a result, both the teachers and students carry misconceptions to a varying degree. If both carry a particular misconception, the teacher in first place may not even realise it and so cannot attempt to remove it from the minds of students. On the other hand, if only the students carry it because of their cultural background it amounts to a barrier in understanding the correct concepts. As a result, it is most appropriate to put our science education under a scanner.

A typical science class

In a traditional science class in most of the schools, the teacher stands at the front of the class lecturing to a largely passive group of students. At most, s/he resorts to blackboard, and to asking few questions during the lecture. The school uses lectures as a means of transferring information from one teacher to many students in one go. However, it is a common but forgotten experience that the extent of information retention is very meagre, when one listens to a lecture (a live one or in the form of a film by a world-renowned expert scientist) giving new information. That is why students back home, rote-learn the topic and do the exercises given at the end of the chapter of the textbook. Later, they take the examinations based on those exercises. In rare cases, the teacher is in a position to resort to experiments or activities. Even in such rare cases, the experiments and other activities operate like passive extracurricular activities. They do not transform the process of science education. The language that serves as a medium of instruction is the main bull-work of science education. Since our examinations focus mainly on the students' retention and retrieval capacities, the education in general and science education in particular continue in the same old fashion. However, the education system makes only cosmetic changes through increase of content load, printing of new textbooks, periodicity of examinations, etc. This education system is not child-centric. Only the child-centric education system can seriously attempt to impart science literacy and wisdom to the next generation. (This is true for all subjects and not just science.) For this change to take place, teachers and the schools should ponder over few questions: "if teachers teach why students do not learn? What are their difficulties? If students cannot learn the way teachers teach, can teachers teach the way students can learn? etc."

The misconceptions of students

A science teacher may tell students to keep their baggage of ideas outside before entering the schools, but it is next to impossible. Children are born and brought up in a religious culture and hence are acquainted with many ideas that science is going to deal with. Students also come across some fantasy leaden variants of the religious answers through literature as well. Students have experience of most of the elders adhering to these answers and so feel those to be correct ones. After few years, a teacher of science tells them that keep your knowledge outside like one keeps shoes outside a temple and come in the classroom. Students cannot do that trick. They come in the classroom with a bag full of preconceived concepts that confront with the possible answer of science with many question marks attached to it. In short, students already have internalised many misconceptions from the surrounding culture. Research[1] has identified reasons behind students' confusions, misconceptions and difficulties in internalising science concepts. Let us see few of them:

1. Students'' ideas do not always evolve as quickly as the rate of concept presentation in most textbooks and in many teacher-designed units of instruction.
2. Language used by teachers and textbooks may confuse some students.
3. There is often unexplored conflict between students' everyday experiences and the classroom or textbook presentation.
4. Immediate introductions of scientific definitions and formulas (many of which are abstract) are not necessarily convincing or meaningful to students. They are useful only when students understand

the underlying concepts. Traditionally many students engage in activities after presentation and discussion about the concept. These activities tend to be verification rather than inquiry-based where students construct an understanding based on observations and evidence they gather.

5. The present education system often expects students to understand before they have a chance to adequately explore and convince themselves of what they listen in the classroom. Ideas are often imposed on students, rather than allowing them to have the opportunity to make sense of something by exploring and developing ideas/models over time. "Covering" the curriculum without devoting enough time for building true understanding is counterproductive.
6. Beliefs resulting from personal experience, intuition, and "common sense" lead students to form their own ideas and models, often well before formal instruction. These experiences and feelings seem to contradict what students read in their textbooks and/or what their teachers tell them. Even with instruction, it is often difficult for students to give up these ideas, or they may revert to them later even though it appears they may have "learned" the correct ideas in class.
7. It is only a teacher who is aware of students' initial ideas, is likely to change students' unscientific ideas. It is similar to a doctor diagnosing an illness. You would not prescribe a course of treatment without examining the symptoms first.

- Teachers and schools (even tests!) often erroneously assume that students understand a concept based on the words students use when describing something (e.g. evaporation).
- Scientific terminology is not a sufficient evidence of learning unless you can ensure that students use the terms with fully understanding their meaning.

8. Demonstrations used by teachers are often passive where students sit back and observe without manipulating materials or experiencing the phenomenon individually or in small groups.
9. Pictures, diagrams, and 2-dimensional models in textbooks and other instructional materials can be misleading, and result in misconceptions.
10. Some of the common analogies used to explain ideas could cause difficulty because the analogies are after all analogies and when stretched too far loose their function.
11. Everyday use of certain terms, often used in non-scientific contexts, contributes to students' confusion. Some words have many different connotations in the English language and the "scientific word" can easily be confused with a common use.
12. Some ideas are just too abstract and difficult for many students who are still at a concrete learning stage.
13. Memorisation of ideas can cause more difficulty, particularly for "academically good students".

Children have and continue to have ideas about how the natural world works. These ideas come from their experiences outside the schools. Learning science during schooling adds some more ideas. Research has shown that teaching is unlikely to be effective unless teachers and curriculum materials take into account learners' preconceptions [2]. Let us see a few such common misconceptions or alternative ideas of students ranging from age five up to age sixteen (and some times of teachers as well). Some of these examples do illustrate the reasons behind the misconceptions enlisted above:

1. Humans are not animals.
2. Classification is mutually exclusive rather than hierarchal (example- some students have difficulty accepting that an organism can be classified as both a bird and an animal).
3. Soil is the plant's food. People put food (fertilizer) in the soil for plants to eat.
4. Plants only give off oxygen.
5. Photosynthesis is a plant process and respiration is an animal process.
6. Living things contain cells (rather than they are made up of cells).
7. Air has no weight (mass).
8. When something is burned, it is used up and nothing remains.
9. When water evaporates, it splits up into atoms of hydrogen and oxygen.
10. The bubbles in a boiling liquid are bubbles of air.
11. Soft things melt more easily than hard things.
12. Mixing colours of light has the same results as mixing colours of paint.
13. Light travels to an object, "lights it up" (is a common expression), and stays there.

14. Constant motion requires a constant force- If you want to keep moving along a horizontal track, you have to keep pushing; otherwise, you will run out of force and just stop. This represents a failure to distinguish the role of friction as a separate force.
15. Objects fall because of two things acting separately- gravity and the weight of an object.
16. Dinosaurs and humans existed at the same time.
17. Rain falls from clouds when they collide and split open.
18. When water evaporates, it just disappears and ceases to exist.
19. Moon phases result from the shadow of the earth cast on the moon.
20. Sun and moon are most often drawn between one to four earth diameters away from earth.

Fragmented culture of science education

Add to this list of misconceptions the difficulties having origins in the culture of science that is different from the normal culture surrounding the students. One may say, and it is true, that the world looks so different after learning science. Let us consider few examples:

- One may give an example of learning the growth of a tree. After learning science, one knows that primarily air and water make the bulk of a tree mass-the trunk, roots, leaves, flowers and fruits. It is interesting to know that when the tree burns or decays, most of the mass goes back to air giving heat that it had received from the Sun. Only the small ash is the part that the tree had taken from earth. This definitely is a very inspiring view of a tree that throws an array of questions. Let us ponder over few such questions: what are the differences in the viewpoint of science and creative arts regarding say a tree? After internalising the viewpoint of science, can one appreciate a tree in a painting, poem, or a sculpture? Can a totem-worshiping person still worship the tree? Can one retain his/her cultural associations? Is it all right to sacrifice one's culture at the altar of science? Does learning science make people **more utilitarian**?

- An example of sexuality begs another set of questions. Each one confronts an issue of sexuality at some stage of life or the other. For science, sexual reproduction is what matters. That is why even a liberal school invites a doctor to talk on sex education with the students. The substitution of sexual reproduction for sexuality is a high level of reductionism. It keeps away the emotional world of both the growing boys and girls that constitute sexuality, miles away. Except the war connotations, science and technology rarely touch the student's emotional world. The student is curious to know the recipe of atomic bomb but is rarely curious about how a flower blooms or how bamboo plant "knows" which year to bloom in? Does **science deal only with the non-emotional world**? Should science deal only with non-emotional world? Does looking at the world through the eyes of science and through the eyes of art and aesthetics creates a dichotomy? Does such a dichotomy operate only at individual level or at social level also?

- The existing curriculum introduces heliocentric theory from class III onwards. They come to know that heliocentric theory replaced the geocentric theory of planetary movements. Some of students definitely remember the names of great scientists involved. However, they do not know the reasons behind such a replacement. They are not aware of the fact that geocentric model also can explain the occurrence of day-night, seasons, and even eclipses. Not only that, the out dated geocentric theory does explain movements of planets on the background of stars, albeit with more cumbersomeness. Most of the students even up to graduation fail to grasp that both these theories are nothing but mathematical models. It is just that one model is more versatile and mathematically more elegant than the other is. The study of science with such an approach forces students to believe that the Sun is steady and planets are revolving around it, forgetting that it is a matter of frame of reference. Similar is the story of the information regarding the heliocentric theory. Students sight the names of Newton, Galileo, Kepler or Copernicus in the discourse on heliocentric theory in the classroom. However, the students fail to establish any correlation between the competing theories and bright sky of daytime or the beautiful sky of the night-time. The Sun, the moon and many stars are visible in the sky but the mute heavenly bodies do not tell the student which heavenly body revolves around which one and why. As a result, in the eyes of students any scientist and Lord Krishna or Jesus is on a same pedestal. **Does that make life fragmented**? One fragment owing its allegiance to science, study, examination, marks grades,

career, marriage-prospects etc. and the other fragment to the other worldviews. The other worldview, for example the snake called *Shesha supporting the earth* is left to exist in a state of neglect. Eventually, the student acquires skills and even explains the occurrence of eclipses. Naturally, s/he obtains good marks.

- Science education helps develop a strong notion that **science deals with material world only**. An example of Newton's first law of motion or the law of inertia is not out of place here. After thoroughly learning it, one fails to understand how come a stray dog lying idle for hours by the side of a road suddenly stretches itself and starts not only walking but running as well without any external force. On persistent coaxing about this puzzle, the student often comes up with an explanation that the law is applicable to non-living things only. The student is happy because s/he finds consistency in the answer with some vague statement that science deals with only material world. One can further confront him/her with an evidence of the effect on persons in a moving vehicle, when the driver for some reason applies breaks suddenly. Now the student is completely baffled. Prescribed textbook does not mention whether the Newton's laws of motion are applicable to living beings, especially mammals including humans. Since the student has to prepare for examination, which does not ask such questions, s/he tends to evade such complexity and concentrates on application of the laws for sailing boats, cycles, aeroplanes and even rockets. S/he gets marks and is happy with a thought that one is competent enough to apply the laws. The stray dog and the rocket that crosses the gravity barrier of earth are in two different law-tight compartments.

The endless list of such examples points to the state of science education today. The science education offers fragmented worldview that deals only with the material world and does not care for emotional world of human beings. The approach seems to be brazenly utilitarian and fragmented.

None the less, students embrace it because they need to acquire knowledge of science and technology for getting a good job. That is what market demands. It is no wonder then that even the 'successful' students carry numerous dichotomies and misconceptions.

The market of science education

Market with its complex forces and ruthless laws regulates the social life. At this level, policies and politics guided by financial interests is at the centre. If selling of a commodity is profitable, its market occupies central stage. It is immaterial whether the product is irrational combinations of medicines, forest products, tobacco, liquor, narcotics, weapons, or viruses (be they in the form of computer programs or biological ones) and antidotes in the form of either anti virus software's or medicines. The market cannot afford to be sensitive to its own effects. It may bring untold miseries to human beings in some or the other corner and may offer comfortable living conditions and even prosperity to people in the other corner of the world. Most often, the market makes the people insensitive to the miseries of some toiling and exploited people. That is why it is supposed to be ruthless. However, keeping conscience in a separate compartment helps an individual prosper and society to sustain the market. Education is just one of the many commodities for the global market. A commodity, that can be sold and purchased, a commodity that has quality dependent upon the cost, a commodity that has use value for the purchaser, etc. An individual possessing this commodity can acquire skills of achieving comfortable living standards. The effect of such commodification cannot be different just because the commodity is education; it is bound to be similar. Students learn to keep scientific theories in one mental compartment and the other theories (misconceptions from the scientific viewpoint) in another compartment. The business of science education cannot address this sort of a dissonance that leaves behind a huge amount of vacuum inviting non-science culture to occupy it. The result of market oriented science teaching and learning is that it stops being holistic. The black holes in the science learning traps students, if not totally gobbles all of them up. A conscious effort to delink science education from ill effects of market and to design holistic curriculum can rescue the situation.

Holistic Approach

The present education is not in a position to tackle the world-views arising from the diverse fields of arts, philosophy, religion, occultism, etc and science holistically. Not only that, the education system operates as if it has resigned from such a task. Individuals have accepted this reality and "successfully" adjusted to it. Even the loose talks based on two basic arguments reflect the acceptance. The two basic arguments are as follows: 1. such dissonances do not matter as far as development of science is concerned and 2. the informal education takes care of dissonances, if at all present. Some times the two arguments have an overlap also. Thus, there is subtle justification of the status-quo of the science education. That goes in to the subconscious mind of many people and revamping the education system becomes next to impossible. Let us see some such arguments:

- Look at the example of Sir Isaac Newton. The discovery of the three basic laws of motion, the law of gravity, some important discoveries in optics and development of calculus go to his credit. Newton gave shape and provided the basic rules of the modern science of physics. However, Newton had one more enduring passion in his life – and that was God and studying the word of God. He believed in existence of 'philosopher's stone' to convert base metals in to gold, the world would end no earlier than A.D. 2060, Bible [3, 4]. The argument is that his belief in occult studies did not interfere in the way of his scientific enquiry and achievements.
- Even today, one finds scientists from the faculty of physics, observing the religious rituals of eclipses or scientists from biological sciences believing in the theory of "creation" or in rituals after death.
- On the other plane, nearly each one of us can sight some names of individuals who appreciate the creativity, skills and achievements in the world of sports, music, poetry, paintings, theatre, films or sculpture on one hand and also in the world of science, technology or mathematics on the other without any interference.
- Such individuals also know that experiences from one creative world can arouse associations from other world. They can skilfully keep the destructive interferences at bay and make use of constructive interferences to enhance the richness of experience of one field. Their life thus becomes rich like the beautiful interference patterns of light or that on the still water when one drops more than one pebble nearby. Switching over from one world of creative activity to the other is not at all problematic for such people.
- One is also aware of the fact that some people had acquired skills and creativity in some or the other field through informal education. In support of such an argument, one sights the examples of famous cartoonist R. K. Laxman, or that of many film actors who never had formal training in their respective creative fields. It is also true that numerous persons in small-scale trades have acquired trade skills without any formal training.

Yes, people do learn many things through informal training. However, that presumes conducive atmosphere and opportunity for informal learning. As far informally learning the skills of a trade is concerned, it rarely helps persons to acquire the theories behind the skills. Secondly, the case of high-level achievements is perhaps the exceptions proving the necessity of formal training. A careful scrutiny of such arguments and examples of people does show the lacunas in them. It is also true that formal training does not guaranty the creation of great minds on a large scale. However, a good quality science education can elevate average level of understanding of science, its application and a training to appreciate different worldviews and place them in proper perspectives. With a better quality of the formal training, the results can be spectacular. As far as science education at school level is concerned, following aspects can improve the quality:

- Study the students' worldview or misconceptions from the viewpoint of science. It has to be an ongoing project because the cultural environment shapes students' worldview and it changes from place to place and from time to time. Some of the origins are from the fields like arts, literature, philosophy, religions, etc.
- Impart such knowledge to teachers before they interact with students.
- Let us not forget that we the people do need fantasies. Encourage students to appreciate these worlds. Do not negate the inputs of such fields; rather help students make a right place for it in their minds. The enlightened teachers simultaneously can persuade the students to observe how

science looks at those aspects of life.

- Eventually students should be mature enough to place fantasies from various sources and the theories of science in different compartments.
- They need not dither visiting different mental compartments and the associations they arouse depending upon mood. In short, science need not come in the way of enjoying emotional world of art, literature, theatre, films etc.
- The new curriculum at primary levels should not have subject matter divided along the lines of today's man-made disciplines.
- Thus, make the science education holistic by incorporating the contributions of views from other creative worlds of human activities. This is nothing short of designing a new curriculum.
- Let the new curriculum replace the lecture method of teaching by methods that base on activities like experiments, field trips, project work, model making, etc. Remember that Chinese proverb: "I heard, I forgot; I saw, I remembered; I did, I understood."
- At higher levels of education, the heritage of knowledge can slowly bifurcate in to various branches.
- However, at both the above levels the contents and treatments of individual subjects should be holistic in nature. Let the science education not impart a feeling to the students that science teaching is devoid of emotional world.

Conclusion

Though science, technology, and its application has seen lot of progress in last couple of centuries, education and science education in particular has not kept the pace with the development. The most important reason behind this is that education has become just another commodity in the market. Market is oriented to pack it in an attractive package and sell it. In the process, one forgets that science education inculcates a particular worldview. The other fields of creativity and knowledge like literature, music, theatre, films, paintings, philosophy, religion even occultism etc offer different world views. A student in a real world absorbs all the worldviews to differing degrees. However, despite the long years of education, most of the times, students worldview remain fragmented. The fragmented worldviews cause many misconceptions in the minds of students leading to difficulties in science education and/or strengthening the fragmented worldviews. Only the child-centric holistic approach to science education can tackle the problem of multiple worldviews and provide the perspective to appreciate, to critique and to apply them in proper context. The paper argues that such an approach to science education enriches many faculties of students.

PLENARY II

STATUS OF SCIENCE EDUCATION IN INDIAN SCHOOLS AND COLLEGES FROM CURRENT TO NEW

006 NEERU, SNEHI (Department of Higher and Professional Education National University of Educational Planning and Administration 17B Sri Aurobindo Marg, New Delhi-110016). BASIC SCIENCE IN HIGHER EDUCATION - CHALLENGES AND OPPORTUNITIES.

Science and technology education is an integral part of school and higher education sector. The influence of swift developments taking place in the S and T sector has transformed the political, social, and economic scenario of the national growth and development. The contribution of science and technology is recognized for national development as science generates a powerful intellectual resource that enables mankind to understand natural phenomena and convert them into usable resources for socio-economic development and a sustainable environment. Further its applications are the driving forces for future developments of all the nations and are fuelled by generation, dissemination and effective use of scientific knowledge across different regions. It is perceived that the basic sciences (biology, chemistry, mathematics and physics) are fundamental to the understanding of natural phenomena, natural and man-made disasters, discovery of new products and techniques and to the application of science and technology for socio-economic development. In India the efforts for promoting the S&T were initiated by developing the policy resolutions, The Scientific Policy Resolution of 1958, The Technology Policy Statement of 1983 and the recent Science and Technology Policy 2003.

In the post independence period, along with the expansion of Indian higher education system, the science and technology education system has also expanded significantly. Apart from the University, departments and colleges, several institutions, governmental agencies and departments for specialized learning and research in different areas of science and technology such as IITs, IISc, CSIR, DBT, DOE, ICAR, ICMR, DAE, ISRO, DST and other National research laboratories functioning under the aegis of CSIR and DRDO have been set up to provide the necessary impetus to research and development in the country. The contribution of these developments in improving the science and technology scenario is enormous. In addition UGC has also launched various programme and projects such as the Scheme of Strengthening of Infrastructure Facilities in Science and Technology (COSIST) and Special Assistance Programme (SAP) to assist, on a selective basis, science and technology departments in universities and colleges.

In spite of these initiatives, concerns regarding the status and quality of science education provided in universities and colleges are being raised at different forums. There is a common perception that access to quality science education is limited. Standards of teaching and research are declining. In fact during the last ten years it has been pointed out at several forums enrolments in basic science courses declined while courses in applied science and technology were in great demand. It is in this context this paper attempts to review the status of basic science education in Indian universities and colleges, policies and schemes being implemented, challenges faced during implementation of programmes/schemes of science education. The paper also attempts to analyse the existing opportunities to further strengthen the quality and relevance of basic sciences education in the country.

007 ENGINEER MEHER, H. (Bose Institute, 93/I, APC Road **Kolkata 700009**). THE INDIA SCIENCE REPORT.

The first ever India Science Report was published, in 2005. Dr M S Valiathan commissioned it in his capacity as President, INSA. Its Foreword, written by Dr R A Mashelkar in his capacity as President, INSA, tells us that the Reports scope was very wide: it was full of phrases like, "...being brought out at an

opportune time. India's prowess in Science & Technology was recognized just last month in a first ever cover page story on an Indian S&T by New Scientist"; "....is becoming a major global knowledge production hub with over 150 foreign companies setting up their R&D centres...", ".... move from the path of 'imitation to innovation' "; "....first signs of reversal of brain-drain are visible" etc. The report dealt with three topics: Science Education, Human Resources and Public Attitude towards Science and Technology. Four years later, we can ask whether the Report has had any influence on the ground? How extensively has it been discussed by science teachers and by the policy makers who make up the main workforce of the country's science education? By India's parents? In the print and electronic media? The questions are relevant. Any report on the state of Indian science, particularly the first ever such report in the now more than half a century old First Indian Republic, and in the 21 st century, is meant for everybody. I shall review its main findings. Its last section, "Looking Ahead", refers to the future. That future is here. Where does the country stand today in the matter of educating its people in science?

008 RAJBONGSHI, M. And RAJBONGSHI A. (Genius Academy, North **Lakimpur- 787031. Assam).** BASIC SCIENCE EDUCATION WITH SPECIAL REFERENCE TO ASSAM.

Indian science is gripped by a Crisis like never before. Science in pre-independent era flourished like anything. We had many original thinker and scientists of repute. Right from Ramanujan in mathematics, C.V Raman's Effects, leading to Nobel Prize to the invention of cholera toxin and laudable contribution toward structure of collagen and foundations of protein structure, India's scenario in the field of science was fresh and energetic. Many brilliant student during those times opted for basic science and the then universities, number of research Institute and number of students' enrolment comparatively are growing up, the very essence of research and environment of creativity among student studying in Indian are wreathing away.

After sixty years of independence, the science education in India is not up to the mark. Many reports from time to time are published and put forward many suggestions. Just like water in the river, the suggestions have passed away and the deterioration of the Indian educations continues. The National Institutes of Science, Technology and Development study's report based on ten years enrolment data, says that priority for science education is on the decline. Majority percentage of science student is in affiliated college with inadequate library and laboratory facilities, over crowded students and poorly staffed. Even those highly motivated few, who do post graduate in science and research are confronted with outdated curricula, uninspiring teaching, disinterested teachers obsoulte laboratory equipments, lack of academic environment etc. The Yashpal report " Learning without Burden" reveals that children don't enjoy learning. The teaching is text book centered. Also the present examination systems instills fear and encourage cramming.

Keeping these drawbacks in view, this paper plumbs the challenge and attempts to indigents positive values, esthetic sensibility and road map of education for the future India. The academic leadership which is the mentor of quality culture is one of the responses to prevent attrition. The authors noted another vital point for which our education system cannot keep pace with the developed countries, that is Indian universities are mired in mediocrity and bureaucracy, where as in world- class universities of the Western Countries no system compromises with meritocracy and pursuit of innovative thinking.

So for as the educational health of the North-Eastern region of India in general and Assam in particular is concerned, the authors try to depict anatopical picture of science education. The critical analysis as shown in the paper may comprehend as to why the students do not give first priority for science education. Why the students belonging to this region can not cope with the rest of the country is another important area of concern. Finally, this paper tics to draw conclusion on the NKC's reports and raise a pertinent point in the forms of question- Does India, spending large sums of money or copying the academic model of the US, succeed?

009 SHAH, AHMAD ALI (Chemistry Department, Thoubal College, **Thoubal 795138**). STATUS OF SCIENCE EDUCATION IN INDIAN SCHOOL AND COLLEGES.

Till now many of the institutions in India cannot necessarily develop scientific temper or scientific culture. Their laboratories operate only in accordance with the old and so to say the outmoded syllabi and without proper linkages with industrial applications. In some of the colleges, the standard of laboratories are such that they seldom have necessary requirements like samples, specimens, chemicals, glasswares, equipments etc which impart practical so as to certify the coverage of syllabi only. The way in which the experiments were conducted are not to the extent of satisfaction of both the teachers and the taught. Some of the laboratory rooms itself do not suit for being science laboratories which expect primarily to be well airy in addition to the facilities of lights and fans, working tables and racks, tap water and skinks, chimneys and other necessary requirement. There are many laboratories with very poor set-ups and laboratory materials lying very much haphazard.

In this advanced and technological age, every institution should be highly modernized. Classroom should be extremely attractive. Sitting and writing materials should be so arranged in balcony system or any other system having rows A,B,C..... arranged in different row height. There should be projectors/LCDs in every classroom. Explanations should be with removable inks. Every models figures, charts, and other possible items should be put into the projector to be displayed on to the screen. Practical should be conducted with well-experienced demonstrators. Every required material should be arranged in advance for the foretold experiments and should be earlier displayed. Strict demonstrations should be done ahead of actual practical experiment. The practical must be monitored by teachers and made necessary rectifications.

In degree courses syllabi should be preferably technological and industrial based. Outmoded and unadvanced materials of the syllabus should be substituted by advanced materials. Syllabi having practical applicability in the day-to-day life of developed humankind should only be inducted. Government's response for modernization and advancement is highly needed. Enabling IT application can throw open new vistas of knowledge generation.

PLANERY- III

STATUS OF SCIENCE EDUCATION IN INDIAN UNIVERSITIES: FROM CURRENT TO NEW

010 MAJMUMDER, M. N. (B14/349,kalyani, **Nadia, WB-741235).** PROVOCATIVE VIEWS FROM A NATIVE INDIAN CHEMICAL EDUCATORINDIAN CHEMISTRY NEEDS ROOTS TO THE SOIL & UNIFYING HANDS & BRAINS.

Retd. Prof. of Chemistry & Dean, Faculty of Science, University of Kalyani, Nadia,WB Indian chemistry text books and syllabi at the UG & PG levels are heavily dependent on international text and reference books. Research problems are also taken from books and journals from Developed Countries (DCs). Better research works are also published in their journals and benefits, if any, from them, are also reaped by them. Most costly instruments, equipments, materials are also supplied by their Cos. Many of our better students trained with Indian peoples' money migrate mostly to USA to work as chemical "coolies" or skilled laborers in their R & D and Industries. Most of the Indian chemical industries in India find it easier and cheaper to use imported technologies. Even for solution of our industrial, environmental and other needs we can not do without foreign advice and expertise. An evident NEXUS among foreign instrument Manufacturers, Chemical Giants and Publishers can hardly be missed. GOI, technocrats, bureaucrats and academicians willy-nilly have become servile to the foreign big capital. Is it not INTELLECTUAL COLONIALISM which results in the perpetuation of India under development inhibiting self reliance too?

The noble idea of Internationalism in Science, developed and nurtured by the Great Pioneers of Modern Science, became nearly dead since the days of WWII. An emphasis on secrecy and patenting is indicative of the erosion of this ideology. The present explosions in scientific knowledge embody and reflect the direction of movement of interest of big capital in its eternal quest for profit and power not all of which constitutes progress of science and of humanity. Many areas concerning the needs and aspirations of the people remain underdeveloped or undeveloped. Nature's chemistry, chemistry of solar energy utilization, small scale chemical industries with indigenous raw materials, small scale biorefineries, eminent public health problems like arsenicosis, fluorosis remain unattended.

Indian chemical education and research even before Independence remained much below the Western average. But whatever grew up in British India under the august influence of the early British educators in the 19th century, got international recognition and respect. But after Independence, particularly during the last few decades, Indian chemistry lost not only respect, even earned notoriety as replete with plagiarism, data manipulation, even cooking up.

Indian scientific workers seldom can think independently originally, tackle new chemical problems on their own. Such dismal condition of Indian science is beyond remediation through reforms as realized by JBS Haldane in the late 1950s and Richard Feynman found for Physics in Brazil. Some suggestions for reforms:

1. Course contents, syllabi must have to be reduced. Cramming and memorizing discouraged. Exam oriented learning must stop. Too much information inhibits creativity and imagination.
2. Text books should also contain neibouring areas of chemistry, eg, Industrial chemistry, Environmental chemistry, Biochemistry, Geochemistry, Cosmo chemistry. These will give an wider perspective and will help students to understand how principles of the science of chemistry are applied to other fields and newer problems.
3. Chemistry, predominantly an experimental science, has been reduced to a subject like History with practical works marginalized. Visits by students to production centers and chemical industries, some I used to conduct in the 1960s, have been discontinued altogether.
4. Chemical labs are not yet "Greened" in India. Some practical works where they are continued still,

are conducted under very polluting and hazardous conditions. Greening of chemical practice in teaching and research is not difficult altogether, nor very expensive either. The faculties of chemistry depts., authorities, as also the greater society, are as yet indifferent to the health and pollution of the environment.

5. Chemical Demonstrations which the British educators introduced in Bengal in the 19th century which got dropped since the late 1950s, should be reintroduced.
6. Chemistry depts should be reorganized with addition of an Extension and Production wing for social service, technology and income generation following the pattern of Land Grant Universities of USA, the Extension Depts of Indian Agricultural Universities. Our Medical Colleges have teaching and research activities as also Hospital services for the public. Then why our chemistry and other university depts. Can not have production centers, of course, on meso scale (i.e. gram or kg scale), of fine chemicals, and small equipments etc. A look at the Sigma or Aldrich catalogues will be revealing. These will bring financial autonomy and foster regional development and unleash creativity of the people. Such a reformed university will be a better Indian University.

011 PATEL, VIBHUTI (PG Department of Economics, SNDT Women's University, Church gate, **Mumbai-400020).** SOCIAL SCIENCE EDUCATION IN INDIA.

The discourses in social science have generated a renewed interest in the thrust areas, methodologies and methods of teaching-learning, knowledge-construction and research in social science. Positivists and naturalists are criticized by critical theorists-Marxists, feminists and post-modernists; while quantitative researchers are challenged by those who favour qualitative and dialogical ethnographic techniques. In turn, mainstream social scientists have responded sharply and have provided restatement of their commitments. Inductive logic, a reasoning process of generalizing from facts, instances or examples and deductive logic, a reasoning process of logical reasoning from stated propositions have played major role in practicing social and political theories in social sciences.

Social science education is increasingly influenced by controversy over different conceptions of scientific thinking. The basic conflict is between those who view science as being objectively based and those who see scientific work as being based upon personal and societal variants such as values, feelings, and needs. The debate between value-free and value-based, ethical research has been particularly strong in fields of social science. A growing body of social scientists is demanding social relevance of the education system in solving socio-economic and cultural problems.

In the post-1970s period, due to pressure from social movements; radical economics, political science and insurgent sociology, anthropology, social psychology, history and geography have incorporated subaltern perspective. In the post colonial period, drawing upon hermeneutics, post-structuralism, psychoanalysis, and post-modernism, new social science streams have created democratic spaces for the marginalized and socially excluded sections of society. This has resulted into generation of an alternative grammar of concepts informed by an ontological stance rooted in poststructuralist theory. Major socio-political struggles such as fight against imperialism in the developing countries, rise of cultural nationalism and identity politics in the context of worsening economic crisis, women's movement against violent patriarchy, the apartheid regime in South Africa have had major repercussions on social science epistemological perspective.

With in each social science discipline ideological battles are on regarding inclusion and exclusion of some topics/subjects. In economics, tug-of-war between neo-liberal economics versus institutional economics, financial economics versus public economics is well-known. Similarly, in sociology, critique of structural functional analysis forms the basis for insurgent post colonial sociological theories. In psychology, phenomenology, social psychology and psychoanalysis have challenged narrow, quantitative manner of inquiry. Political science syllabi have included papers such as social movements, human rights, peoples' struggles, People's participation in decision making, decentralization in governance. Gender Mainstreaming in all social science disciplines forced reexamination of all meta-theories, presumptions and foundations of tools of analysis. This has resulted in major changes in concepts, goals, objectives, vision, mission and theory of social science education. There has been serious questioning of "value neutrality" in social science teaching and research.

Inter-disciplinarily in social science teaching, research and construction of knowledge is welcomed. New pedagogy of social science education has widened the horizons of human sensitivities to socio-economic inequity and inequality based on caste, class, ethnicity, race and religion. New areas of critical inquiry such as women's studies, dalit studies, tribal studies, study of social exclusion and inclusive policies, peace and conflict resolution, cultural studies, human rights education have gained legitimacy in social sciences. New system of social science communication has included plural sources of dissemination of knowledge and relationship of mutuality between teacher and the taught. Democratisation of class room teaching by ensuring interactive methods is emphasized in social science education. Internet based dissemination of social science researches, vocabulary; theoretical formulations have encouraged even those who are initiated in social science education to orient themselves to social science intellectual discourses.

Professional education is increasingly becoming the primary determinant of upward economic mobility in the emerging knowledge economy. The state has started showing less interest in social science and profit oriented private sector does not find social science education commercially viable. In the mainstream education, the status of social science education in Indian schools and colleges is deplorable in terms of infrastructural facilities, quality of teaching, teachers and students strength. In the higher education system, position of social science education is the lowest in the academic hierarchy. Social scientists have pointed at danger signals regarding neglect of social sciences. In Distance and Open learning mode of education, social science education is gaining popularity throughout the world. Social science courses at Indira Gandhi National Open University, IGNOU have takers from all walks of life, all streams of society and all sectors of knowledge economy.

While dealing with challenges faced by social science education in India, we need to address some crucial mind-boggling issues regarding role of education per se. Is it to create a concerned and informed citizenry that would deepen our democracy? Or to meet the expected future needs of economic and social development in the country? Or, simply to meet the labour requirements of international corporate capitalism? Can a balance be achieved between these aims? This is important because the current emphasis on producing particular technical and managerial skills ignores one of the most important functions of education, which is its critical role in encouraging creativity and construction of knowledge leading to intellectual self sufficiency to face the challenges of contemporary complex knowledge-driven economy. A focus on purely technical or absorptive skills can lead to a downgrading of the process of encouraging analytical capacities, or creating questioning attitudes and socially necessary dissidence. Since educational institutions form the very soul of a society and typically create the space for both creativity and social introspection, downplaying these important features of education provided by social science education can have a deadening effect upon society.

We have to meet a major challenge to evolve new democratic and ethical system of social science education reflecting peoples' democratic needs, aspirations and creative urges.

012 PANDA, DEBABRATA (Editor, Bharatiya Samajik Chintan 1224/4, Dr. J.R. Dhar Road **Kolkata- 700028).** SOCIAL SCIENCE EDUCATION HOW TO MAKE IT SOCIALLY WHOLESOME.

India has a vast army of competent social scientists. Even then the scourge of disease, poverty, ignorance, hunger and malnutrition haunts our daily existence. The most pertinent factor behind this apparent paradox is blind imitation of the Western system of social science education. The compartmentalized approach and the a sort of caste and status conscious hyper- sensitivity of the influential social scientists and the consequent highbrow mentality of those now ensconced in administration and institutes of higher learning remain a major stumbling block on the way to studying the social problems in their entirety. Come what may to the society at large, the leading figures in the field of social science are happy to get their research work appreciated by the top notch bureaucracy in the World Bank or the cult figures in the leading US and European universities. As the medium of research is till date English, the fruits of such valuable work do not reach the level of those who are not proficient in English

but are otherwise persons gifted with sensitive mind. The very concepts to which the young learners are introduced often blur the vision of even the inquisitive souls. Our students most often fail to understand why antagonisms prevail in the society. The very curriculum and the textbooks are so designed that our students cannot understand the inner laws of social dynamics. As such, to most of the students of the university system, capitalism seems to be a social system which is not transient. It is high time, therefore, that compartmentalization should be bid adieu and social science education should lay adequate stress on studying political economy, the science of studying social relations that evolve among peoples in the process of production, exchange and distribution. It will be good if the students are given lessons on political economy outlined by all schools and trends and not simply the Classical political economy and the scientific exposition of the law of social dynamics by Marx and Engels. That will help the worthy citizens of tomorrow to choose the right path of social change and to discard the reactionary path that creates confusion in the ranks of those who are eager to change themselves and change the society. There is ground for hope as India has a number of really talented teachers who do not hesitate to call spade a spade. Their unflinching commitment to society is a valuable treasure. They will blaze a trail and hasten the birth of a new society by revolutionizing the social science education in the country.

INDIA has a large contingent of trained social scientists including a good number of gifted economists, talented archeologists and historians, eminent political scientists and sociologists, and some brilliant psychologists. Every year our universities are churning out social science graduates in large number. The annual volume of academic research in various disciplines of social science is indeed a cause of envy of any other under-developed country. Some of those who were trained by our university departments and research institutes have already won recognition in the West as accomplished scholars and distinguished researchers. The remarkable growth of research activity in the field of social science was prompted by the genuine urge to decide our own fate, to ensure development in a way that would solve our basic problems of food, clothing and shelter. In a way the emotional aspect of this urge is not at all negligible at least when we judge it from the position of the peoples who were groaning under the colonial yoke for long two hundred years. There was a lurking desire to ensure economic improvement of the most backward areas and bring succour to the neglected sections of the population---goals which were not reachable under the British Raj. Media attention is focused nowadays on various aspects of social processes in which injustice of various forms demands immediate attention of our researchers. It is no doubt good for the society that social scientists take upon themselves the task of elucidating problems that are on people's minds and as a responsible section of the society they suggest some remedial action in order that the society can prepare itself for all exigencies. But here we come across a snag. Our brown sahib mentality does not enable us very often to look at the social problems in their entirety, to study the specific problems afflicting the Indian society from the national viewpoint. If the goal is to gain eminence in a particular discipline, the researchers develop a natural tendency to be in tune with the thought pattern that has evolved in the West in the matter of looking at the society and analyzing its problems. What is missing is the India-centric approach. The anglicized science education--- in both physical and social science---has its curse. The opening is walled up to block the entry of even those scholars who are not proficient in English. And a good number of scientists remain walled up for years, unable to explain how the society can be changed. This is possibly the reason why despite a lot of efforts by the Planning Commission not much headway could be made till date towards removal of poverty, ignorance, hunger, malnutrition and deprivation.

Menace of Compartmentalisation

Changes in society are chiefly due to the development of internal contradictions in society. External factors have a role in causing the change but they become operative through inner laws of development of the society. It is not enough for the social scientists to explain what specific problems we face today. It is not sufficient to suggest some kind of palliatives for immediate relief. Way for the peaceful resolution of the contradictions must be devised. In the Indian society it is not easy to suggest the way for social change without unravelling the complex web of contradictions at each stage in the process of emergence of popular forces that are instrumental in building a truly democratic society. It cannot be done by looking at things superficially or one-sidedly. As the society is one integral whole, its study cannot be complete without observing the problems in their interconnections and totality. The range of contradictions in our society is vast and the contradictions are changing from time to time. For example, the contradiction between forces of production and relations of production and between classes are never static. Conditions differ at each

stage of development that pushes the old society forward toward a new one. With this change occurring in the society and also in the world arena having impact on the internal social dynamics, the particular features of contradiction between the forces of production and relations of production have altered. Similarly, changes have occurred with other contradictions---contradiction between all the oppressed classes in India, between feudalism and great masses of the Indian people, the contradiction between the working class and the capitalist class, between monopoly and non-monopoly capital, between peasantry and the urban middle class, and between the various constituents of the ruling alliance of classes, the contradiction among multinational corporations of the OECD countries. Sometimes changes are imperceptible. At other times such changes take place very fast and become momentous. In recent years the path of neo-liberal development that is being pursued at the advice of the Triad (IMF, World Bank and WTO), there has taken place a remarkable change in internal contradictions within the Indian society. Social scientists have to discover the essence of the process; or otherwise the methods of resolving contradictions will remain beyond the frontier of our knowledge.

In an underdeveloped country like India researchers belonging to different disciplines look at a particular social problem from the angle of the received training, typically along western lines. The ongoing tribal rebellion in the country, for example, may be considered by some fellow travellers as an anthropological issue, some others may look at it as being the result of socio- institutional malady, still others may consider it as an outburst of peoples' anger against plunder of natural resources by global capital especially in the context of rapacious loot of land for setting up Special Economic Zones, while there may be still others who would prefer to view it as a burning issue of social psychology. Those who are at the helm of affairs would like to view it as a purely law and order problem. Thus it becomes difficult to suggest proper remedial action. In this instant case, failure to look at the phenomenon in its entirety leaves the problem undiagnosed and as a matter of fact a peaceful resolution of this complex problem seems to be an impossible task.

Compartmentalisation in social science education has been the result of a blind imitation of the Western system. The intention behind this arrangement was to lay emphasis on creating specialists rather than generalists. The result has been salutary from at least one angle. Specialists of different branches can supervise the work of their juniors, for which they need not approach their foreign counterparts, entailing unnecessary expenditure. That apart Indian social scientists can publish their research materials in foreign journals, their ideas get a much better focus, wider attention of the intellectuals and thus the level of self-confidence rises.

At the same time, however, we have become net losers. The institutes of higher learning in India have failed to generate adequate systemized knowledge of the laws and facts of our society and its people. They have succeeded in producing well-qualified specialists as opposed to generalists who lay much stress on a genuinely broad-based holistic approach to analyse the problems of the society at large. This is quite apparent when we direct our attention to the study of economics in our university system as well as research institutes.

Poor Understanding of Social Laws

In our class-rooms young minds are nurtured in an alien environment. Economic theory which has its origin in the developed capitalist countries of the West is of little us in understanding and analyzing the problems at hand in an underdeveloped country. The ideological underpinnings of the theories in the textbooks pose a major barrier to developing a critical outlook especially because such theories are so designed that the exploitative nature of the capitalist system of production escapes the notice of even the intelligent students.

The exercise begins by introducing the students to the idea of existence of four factors of production. Each of these factors is considered as an independent source of value. Rent is considered as an earning either in the form of Nature's gift or as an earning yielded by situation of scarcity. Interest is shown as an earning of the capitalist in the form of the productivity of capital. Wage is the price of a labourer's contribution to the production process and hence, the question of exploitation is practically ruled out. Profit, the residual income, goes to the entrepreneur as the reward for innovation or for bearing uninsurable risks. This four-fold classification allows scope for inclusion of other factors in the production function like the state, technology, and many other professionals clubbed together as "human capital", such as accountants, trained managers and scientists. It serves to create an illusion that in the post-industrial society power will eventually pass to the talented specialists. Scientists have reason for elation in that

leading scientists are absorbed in the Establishment. But a minute observation will reveal that under capitalism in its monopoly phase of development most other scientists enjoy only the status of dignified workers.

Power remains essentially in the hands of those who own and control land, banking industry and the producing and distributive agencies, publicity, transport and communication systems of the nation. John Dewey, the eminent American philosopher has correctly observed that whoever "owns them rules the country, not necessarily by intention, not necessarily by deliberate corruption of the nominal government, but by necessity. Power is power and must act, and it must act according to the nature of the machinery through which it operates." By sidetracking the question of power textbooks of economic theory seek to drive home the point that capitalism has changed radically in its essence and it is no more exploitative in character. The young learner begins to realise that capitalism is capable of "self-improvement" and hence it is not something transient. Nurtured with this theory, a young leaner is likely to stand on the brink, ready to take the plunge into the "End of History" thesis. This is how the ideological position of postmodernism is strengthened. Indeed with their textbook knowledge very few students come to know that permanence of capitalistic mode of production, or for that matter any other social system, is a patently false belief, because as Engels wrote in the Introduction to *Dialectics of Nature,* 'the whole of nature, from the smallest element to the greatest, from grains of sand to the suns,... has its existence in eternal coming into being and passing away, in ceaseless flux, in unresting motion and change.'

In fine, the four-fold classification of factors is used to conceal the source of value and the denial to the workers of the entire value created with his labour. By disguising the capitalist exploitation the students are not being given an opportunity of having the knowledge of the dynamics of capitalist development and grasping the inner contradiction of capitalism. Failure to provide our students in the initial years a scope to develop scientific understanding of the social laws makes a mockery of social science education.

In our university system, economic theory views the phenomena and the various categories as they are. The historical perspective in which the things have evolved into their current state is almost missing. As for instance, competition and monopoly appear to most of the learners as two distinct phenomena. Not many students come to learn that free competition leads to monopoly and monopoly cannot eliminate competition; on the contrary it intensifies competition. Only a discerning student comes to learn from some sources outside the classroom the process of transition of capitalism from its competitive stage to the monopoly stage and the rise of imperialism at its highly mature phase. The students, in general, do not have opportunity of getting an elaborate explanation of the immanent laws of capitalist mode of production. Nor are they motivated to study the social relations that evolve between people and between people and Nature in the process of production and exchange of the material benefits. They are not much aware of the fact that capitalism reduces everything to commodities and as a consequence, the prime importance of the human factor in economic activities and also in the society is often lost sight of. The results are disastrous: as the students become eventually policy-makers, they fail to realise that in this world the deciding factor is not machine but man, because without man it is difficult to think of any tool or technology; therefore, in any kind of planning it is altogether wrong to attach excessive importance to technical factors while relegating the human factor to a secondary place. In most cases a superficial discussion is held in our classrooms on the role of the human factor in economic development, and that too only casually.

In any institute for study of social science, caste-oriented highbrow mentality has been the bane of its life. There is a general tendency among economists to look down upon their colleagues belonging to other disciplines like history, sociology and anthropology, simply because of their claim to quantitative precision and their unique ability of econometric model building of the macro-type. As the state is in the dire necessity of having a macro plan in order that the most suitable method can be followed in initiating changes that are likely to yield the maximum development effect, economists are given the pre-eminent position among social scientists. So they have come to enjoy the leading status in the caste hierarchy. Possibly here lies the source of degeneration of research activities of economists into unnecessary show of pedantry. In the developed countries reliable statistical data are available in highly organized form and it is not difficult to bring in the non-economic factors into the economic analysis as they 'become adjusted to let economic impulses through'. Gunnar Myrdal rightly says that for the under-developed countries just the contrary is true.

Comprehensive Issues Ignored

If we are to reflect on the Indian reality, then it is totally unacceptable that we can approach the problem of development as a purely sociological problem, or an economic problem, or a mere anthropological issue; like any other problem it is a problem . This is why what is needed is not a compartmentalized approach but a comprehensive analysis. However well-knit a particular theory in a given discipline may be, by itself, it cannot give us a complete analysis of complex social phenomena without unraveling the inherent contradictions and conflicts within a society. Fragmentary approaches cannot go a long way in unfolding the operation of social dynamics, though, in fact, it may not be difficult for a specialist to gain eminence in a particular discipline even without being well-grounded in history of ideas and in the philosophy and sociology of science, only because the person concerned has acquired sophistication in building abstract models or he/she has got the rare faculty of observation of some very crucial aspects of some social problems and exceptional quality of articulation of ideas.

There is much truth in the contention of the Structuralists and Institutionalists (like Thorstein Veblen, John K Galbraith, William Mitchell, Francois Perroux and Gunnar Myrdal) that economic processes of the contemporary social formation can properly be grasped with reference to non-economic determinants such as psychological, legal, ethical, and moral phenomena(customs, habits, instincts)as well as socio-economic phenomena determined by them(the state, trade unions, corporations, competition, taxes, the family etc.),coupled with education and environment, including climatic factors. Galbraith rendered a useful service by drawing our attention to the *Military-industrial Complex(MIC)* which has become a major alliance of military circles, industrial oligopolies and top government officials for the purpose of constantly increasing military strength in the interest of domination by the multinationals in the specific context of arms race and expansion of military industry. With the progress of time, academic scholars and front-ranking academic institutions have become actively involved in military and industrial research as the corporate houses enter the educational establishments in collaborative venture, thereby giving birth to the *Military-industrial-academic Complex (MICA).* In the current global situation the MICA exerts a great negative influence on the politics, economy and social life; this is largely because the MICA bags most of the multi-billion dollar military contracts in all the major economies of the world. In our university system there is practically no scope for a study of the economic phenomena in a comprehensive way taking all these non-economic factors into account.

Using Western Concepts--A Colonial Tradition

There has already taken place a colossal wastage of both time and labour, including intellectual labour, apart from the wastage of monetary resources in promoting some amount of un-science in the name of social science education. No substantial tangible benefit could be derived because of excessive westernization of the content of social science education though, unquestionably, the ability to work with the received theories of the West has earned for our social scientists important positions in administration and academies. Our scientists have their mind glued to the West. It is because of this reason English remains the major vehicle for exchange of idea and medium of research. Scholarly writings in Indian languages are very rare. It remains a major impediment democratic education. In addition, whenever some new concepts are floated in the West, immediately the infection affects our mental process and without little reflection as to why these concepts have been introduced we start using them. For example, as under the neo-liberal dispensation the process of dismantling of the public sector and displacement of labour were insisted upon in the interest of capital; the process of structural annihilation was labeled as *economic reforms,* by the neo-liberalists themselves and the economists working in the administration of the under-developed countries in general. A sort of progressive connotation was given to the process of destruction. Immediately academic economists joined the bandwagon of liberalists and began using the term as a mark of false modernity, oblivious of the fact that in the process they lost their potential as educators. We forget very often that as academic pursuit of social science is made subservient to government officials, no matter what we do to the society, we take the heart out of the of social science.

Sometimes we accept the Western concepts because they are handy and convenient for the academic fellows to follow the discourse and strike comparisons with other countries. Otherwise after sufficient

caution was uttered by no less an academic stalwart than Gunnar Myrdal in *Asian Drama,* we should have been careful enough about the western conception of unemployment and under-employment when analyzing the problem of unemployment in an underdeveloped country like India. In our country, for example, there is structural unemployment of a kind which is non-existent in the West. In a country where there is a large army of the disguised unemployed, labourers are always ready to work for whatever the wage they are paid .The inability of surplus labour (euphemism for disguised unemployment) to find work in the context of an under-developed country is totally different from the inability of workers to find employment opportunity at the going wage rate. What's more, our colonial subjugation is no less focused in our agreeing to the use of the terms such as developing countries as synonym for under-developed countries. The expression does not carry with it the notion of inequality in the former colonies of the present day rich nations. Nor does it convey much about the kind of initiative already taken by the authorities to remove backwardness. On the contrary, it helps to paper over the indifference and lack of dynamism on the part of political leadership and top-notch bureaucracy to promote progress.

Progress of capitalism has substantially conditioned the thought process of the economists, leaving in its trail the dangerous outcome of predatory attack on Nature and common property resources. This is much in evidence in the use of the concept of wealth. Adam Smith, considered to be the founding father of modern economics, was concerned with the nature and causes of the wealth of nations. In course of time after the emergence of the neo-classical school, the concern shifted to the acquisition and accretion of wealth owned by individuals and corporations, conditioned by such factors as (i)wealth ownership and inheritance,(ii)personal ability,(iii)education, training and opportunity,(iv)economic stratification (v)direct payments programmes,(vi) tax evasion and hoarding, and the last but not least,(vii)speculation . While dealing with the question of distributional inequality between nations, Samuelson refers only to differences in concentration of wealth in private hands as reflected, say, in the concentration of land, while maintaining silence about the differences in wealth endowments among nations which may affect per capita availability of resources in between any two countries and thereby may have some repercussion on the politics of distribution. In our country we have been following the same line as regards the treatment of wealth. Here also all the natural resources are not considered as nation's wealth; ownership of private property in land is legally valid and under the pressures of the neo-liberalist managers of state the private ownership is being hastily extended to mining, forests and rivers. *The Penguin Dictionary of Economics* writes the meaning of wealth as "wealth of an individual" that is, "stock of tangible and intangible possessions which have a market value". National wealth finds no place in this definition.

Why This Diplomatic Trickery?

What is important for us to note here is that by this diplomatic manoeuvre of the meaning of wealth, scope has been widened for plunder of natural resources which are no more given the honour of wealth; they are treated at best as public property. As the marketers' grip over policy formulation has been tightened in recent years, the spree of privatization poses an immediate threat to bio-diversity which is a common inheritance of humanity. Large scale destruction of bio-diversity is mainly due to mega development projects and a planned push toward biological uniformity and monocultures (in the form of Green Revolution in agriculture, White Revolution in dairying and Blue Revolution in aquaculture and fishery) which the environmentalists have been repeatedly pointing out. All this modernisation drive is prompted by the urge to ensure increasing productivity. The incredible mad rush to gear up the growth process has posed a serious threat to the sustainability of ecological balance. Sustainability and diversity are ecologically linked. Multiplicity of interactions allowed for by diversity can heal ecological disturbance to any part of the system, while with biological uniformity, if there be a disturbance to any part of the system, ecological disturbance tends to be amplified. What is more, the compulsion to promote growth is itself a value-laden compulsion; in today's context; it is propelled by the *Grow rich quick* mentality. The growth process with built-in destruction is favoured by global capital. Capital's destructive production which is advancing at an alarming rate has already wrought a huge destruction of life forms, culture and habitats of the Earth's indigenous peoples deriving their livelihood from diversity. Interestingly enough, while highlighting the high productivity aspect of the growth phenomenon what is ignored is the value of the diversity lost, measured in terms of value of products consumed directly by different communities(fish, firewood, cattle fodder, food items directly gathered from forests like fruit, game meat and roots); value of

products commercially exploited(like honey, fish, wood and hosts of household items made from forest and sea products);and indirect value of the ecosystem functions(such as, watershed function, photosynthesis, regulation of climate and production of soil).

To cap it all, the fruits of monocultures in the form of increased productivity are being hijacked by the big corporations; they exercise their oligopoly position in an effort to fill their coffers through their policy of *seeds imperialism*, strengthening their sway over the global seeds market by means of destruction of the variety of traditional seeds of the Third World countries and replacing them with the biotechnologically engineered seeds , while widening market for chemicals, insecticides and fertilizers. The farmers and consumers in general are the worst sufferers. Efforts to patent seeds and increase monopoly rents, charged to farmers will raise food prices and lower their income. The neo-liberal global (dis)order has resulted in so much reckless exploitation of Nature that very little of resources will be left for future generations and a severe ecological imbalance has already posed threat to life on this planet. Teachers who are conscious of their role in the society should go ahead with a concrete agenda of properly orienting their colleagues having a myopic view of the social transformation in order that students are guided along a right direction to usher in the much desired social change. They have to fight also for rectification of the curriculum wherever and whenever it is so required. The task is difficult. But "everything starts out difficult".

Study of Political Economy is the Need of the Hour

To be able to deal with comprehensive issues a scientist has to move along a scientific path. Out of many possible ways available for the study of a given society there is certainly one scientific approach. For the study of the global situation too there is only one scientific approach .That is the science which studies the social relations that evolve between peoples in the process of production, distribution and exchange of the material benefits .This is *political economy*, pure and simple, as explicitly made clear in *A Dictionary of Political Economy*. (M. I. Volkov ed., Progress Publishers, Moscow, 1985)

Right from the days of mercantilism down to the modern age representatives of different schools of political economy have always expressed the interests and ideology of one or the other class and they seek to justify the economic policy corresponding to its interests and safeguarding it. Classical political economy and its representatives like William Petty, Quesnay, Adam Smith and David Ricardo presented a progressive approach in that they defended the interests of the bourgeoisie in a period when the bourgeoisie constituted the ascending class. At that time the internal contradictions of the capitalist mode of production were just evolving and they could not therefore grasp the transient character of capitalism. But later the contradiction between capital and wage labour grew; classical political economy lost its scientific character, leaving behind its valuable contribution in the form of labour theory of value. Somewhat later those who eulogized the capitalist mode as one in which the harmony of class interests were supposedly present, failed to observe the internal contradictions of the capitalist system. They represented the reactionary trend within the Classical political economy. Malthus, Say, Bastiat and others were representatives of this reactionary trend. The later day "neo-classical synthesis" combines modern methods of microeconomic analysis with the principles of Classical political economy. It is yet another reactionary school as it is opposed to the study of the laws of social dynamics in a historical perspective. Marxists try to understand the interconnectedness of the social contradictions and the laws of ever changing social relations and ceaselessly developing forces of production. By focusing our attention to this aspect continually changing social contradictions, Marx and Engels practically revolutionized social science and broke new path for political economy. They unveiled the interconnectedness of contradictions within the society and outside; while directing our attention toward the transient nature of everything in this universe, including Man and society. To be sure, nothing exists unconnected with other things; nor is there anything fixed and changeless. Everything is transient and it is in continual change and motion.

This philosophical approach enables us to pay attention to the opposite, conflicting tendencies arising throughout the Nature and society, whose struggle results in change and development. Obviously then the contradiction between the political and cultural superstructure, on the one hand, and the economic structure, on the other, will be revealed and the intensification of contradiction leading to political and social tensions can be properly diagnosed by the social scientist. In his /her endeavour to understand the social conflicts the scientist is required to find out the process of socio-economic exploitation which results in inequality. Once the secrets of exploitation are unveiled, it is not difficult to proceed further and

ascertain in the national and also in the global context the specific action of the law of uneven development .Then the picture of domination of some interest groups and classes in a parliamentary democracy and that of the domination of imperialism in the world arena do not appear any more as things beyond comprehension.. In the social science discourse in class-rooms there is at best only marginal scope for this kind of scientific study of social phenomena. In the discourse in economic issues, for example, the interrelationship between social structure, politics and economic decision-making are touched upon only superficially. As a consequence very often a student, unable to probe deep into an issue, is tempted to believe that the cause of the problem at hand does not lie probably in this material world ,and the cause of all the motion and change can be traced possibly in a "higher" spiritual reality. Situations like this are not really uncommon; the fatalistic attitude that has gripped our society like a virus is itself an indicator of the poverty in the field of social science education in India. Communication of pseudo- science in our schools and universities is reflected in the psychic state of students and teachers involved in the study social science. They are equally victims of fatalism. There are exceptions but that by itself is a measure of the severity of the epidemic.

Unable to comprehend the laws of uneven development under capitalism, social scientists working in academic institutions have been circulating the theory that by stressing on productivity first a country like India will succeed in catching up with the advanced countries of the West. They are little aware of the fact that the perspective in which today's developed countries attained high rate of growth, is altogether absent now in any under-developed country and it is unlikely to appear in future. Furthermore, by peddling the theory of high growth development, these scholars are in fact sowing illusion of sustaining the growth process in the decades to come. If they are not guided by any ulterior motive, then certainly they themselves are yet to rid themselves of the illusion that capitalism has a bright future. Whether they like it or not, however, capitalism is caught in the throes of an irreversible crisis. In this situation capital is desperately seeking avenues for profitable investment in any corner of the globe. It is ironical that some of our social scientists are practically championing the cause of global capital, circulating pernicious theory of FDI, acting as panacea of our economic ills. They are spreading the false belief that a rise in the volume of FDI will usher in a stage of prosperity through employment generation, as if jobless growth is no more in the agenda of global capital.

Institutionalism which made its appearance in the late 19th century aims at defending the interests of state-monopoly capitalism. They believe that with appropriate "social control" it is possible to tackle the crisis of capitalism. Their contention was proved wrong in the wake of the world economic crisis of 1974-75, precipitated by the shortage of raw materials and energy crisis. Similar was the fate of the "neo-classical synthesis"-- a blend of neo-Keynesian and neo-classical concepts of reproduction aimed at synthesizing the regulatory role of the capitalist state and the spontaneous self-regulation of capitalist reproduction through the market. It also failed to find a way out of the impasse. That did not deter the social scientists produced by our institutes of higher learning from traversing the path of vulgarization of political economy, only because most of them are unaware of the fact that imperialism has finally and forever lost its former unbridled sway despite globalization which is the other name for global spread of capitalist production and exchange relations. Intensification of competition among global giant corporations of the three major economic powers—US, Japan and Europe--- is open to verification. Unlike *economic crises of overproduction,* which appear periodically and are overcome by suitable measures aimed at stimulating effective demand, the general crisis of capitalism in the form of disintegration of the world capitalist system cannot be prevented from taking place. Globalization has paved the path of jobless growth, greater destabilisation of the polity and massive environmental destruction. Structural adjustment has turned into a structural annihilation of the under-developed world.

While stressing on the importance of the study of political economy in our colleges and universities, it should be stressed that in all fairness, students should be introduced to all the different schools and trends of political economy, beginning from Classical and Marxist political economy down to modern bourgeois political economy---represented by Rostow (stages of economic growth), Galbraith (new industrial society), Raymond Aron (uniform industrial society), and Daniel Bell (post-industrial society). There is no scope for authoritarianism in the matter of choice of specific political economy to be included in the curriculum. It is fair to note that there is scope for this study in our curriculum. But almost everywhere it is not given sufficient importance it deserves. It is not enough to say that only a scanty attention is paid to the study of political economy in social science disciplines. Even that small exercise is done mostly with a metaphysical outlook, with a positive status quoist approach. On the contrary, a much larger time and

attention is given to explaining the accepted theories of the respective disciplines and that too with little consideration of their suitability to explain problems in our context.

A Multi-Disciplinary Approach Called For

The interrelationship between social structure, politics and economic decision-making is so obvious that it does not merit elaboration here. What we want to specially focus is that every student of a social science discipline should be equipped unmistakably with some basic knowledge of history and philosophy. Knowledge of history enables a student to summarise the experiences of peoples in motion not only in India but throughout the world. That will develop the students' capacity to think and perceive differently or in a new way, which is, for all practical purposes always more important than the knowledge gained. There is, of course, the additional rider: our students are in critical need of having the knowledge of the history of human mind. They should be motivated to study history, as Voltaire felt "dealing with, not kings, but with movements, forces and masses; not with the nations but with the human race; not with wars but with the march of the human mind". The study of date-and-fact history is of no use. Our students are already sick with the kind of history which is nothing more than the picture of crimes and misfortunes.

They should be encouraged to know what steps men had passed from barbarism to civilisation and how human civilisation followed a zigzag course in different phases of societal development. It is indeed a difficult job as the educator is required to unearth the history of the human mind from under the debris of political events.

The connection between philosophy and politics is a necessary one .Politics affects our everyday life No one can escape this destiny. This is the reason why politics cannot be left to professional politicians, even to the most gifted amongst them. Here lies the role of social individuals more specifically, the philosophers who have the power to address comprehensive issue. Philosophers from the days of Greek Antiquity to the present times tried to intervene in the political process aimed at actively redressing the situation. But they had to pay heavily in terms of personal sufferings as they were accused for their acts of misdemeanor. Socrates, Plato, Campanella, Giordano Bruno, Machiavelli, Hobbes, Spinoza, Karl Marx and Gramsci --- these are the names of some of the leading figures to illustrate the point. As the comprehensive issues are missing in our formulation of public policies , we fail to realize that our basic problems such as of food, clothing and shelter for all cannot be solved through the application of economic measures alone. It necessarily calls for a radical social transformation and in the final analysis what is needed is a political solution. For reasons quite obvious, our colleges/universities cannot be expected to impart a kind of training along the line suggested here as it is very likely to disturb the *status quo*. Nor is it desirable also beyond a certain limit .The limit is set by the level of political tolerance.

Unless the level of political tolerance is set somewhere close to zero, it is desirable that in our under-graduate/post-graduate curricula there should be ample scope for the study of political economy in order to develop the mental faculties of our students required for conducting independent analysis of the present day reality. Otherwise modern institutions will remain huge monuments of wastage of the country's valuable resources in order to aid the process of career development for a limited few beneficiaries .In an interview with Elias Kanelli(which appeared in *Po Vima* in Athens October 25,1999) Istvan Meszaros, the author of *Beyond Capital,* did correctly observe: *...intellectual production—under the pressure of capital's imperatives and determinations—tends to be fragmented into countless specialisms, at the great detriment of the comprehensive dimension.* A comprehensive look at the social issues is possible with a philosophical hindsight. Because of the fact that most of our educators have deficiency on this score, social science education has failed till date to produce talented researchers in quite a good number .The lack of a comprehensive approach toward social issues under study is responsible for a myopic view taken by the scientists in their policy formulations. Economists have a tendency to get them excessively occupied with the present, probably assuming that the last decade or two constitutes a general norm of world history. Otherwise how could they endorse the IMF-World Bank prescription of structural adjustment programme? Even when they now insist on further 'reforms' do they ignore what happened to the "tiger economies" in the not too distant past? Or what happened to Argentina, only in recent years? Why is the case of Brazil as a "success story" not being touted once again? Possibly the economists are prone to assume that "the economies of other countries and of other times have worked in the same way as their own country and their own time". Time has come when such irrational notion should be bid adieu.

Did The Exercise Fail?

While destructive production takes place in broad daylight, our academic social scientists prefer to maintain an awkward silence and the students tutored by them also adopt a more or less indifferent attitude. The plunder of our resources by transnational capital goes on unchecked. Thus social science teaching in our campuses .has failed to generate dynamism in the thought process. Unable to explain the social reality, it could not kindle in the enlightened minds the desire to transform the world..

Had there been spontaneous development of the various branches of social science in India, the situation would not have taken such a depressing shape as at present. The thrust to social science studies came from outside under the care of the Ford Foundation initially. It will not be out of place to note that there was an abrupt spurt in social science study in our country when at the behest of the Planning Commission, the Ford Foundation chalked out a programme to fund social science research in some of the major universities in the country and set up some institutes outside the government in order to provide independent sources of economic data and plan evaluation, while creating room for management caliber. (Incidentally, the Ford Foundation decided to promote Ph.D. programmes in disciplines of social science in a number of India's leading universities and research institutes in the years between 1954 and 1965, while playing a major role in the founding of NCAER, Institute of Economic Growth, Delhi, IIM at Calcutta and Ahmedabad besides strengthening economics studies in such front-ranking institutions as Indian Statistical Institute and Gokhale Institute, Pune) . Indian economists today occupy prestigious faculty positions in Western universities and also senior administrative posts in IMF, World Bank etc, thus proving beyond doubt that the institutes of higher learning in India are able to generate knowledge of economics at par with the world level. Economists themselves feel proud that as a social discipline economics has become a "hard science", similar to physics and chemistry in as much as mathematics can be applied to analyse economic behaviour and to forecast the outcome of changes in the key variables It well known that the Ford Foundation had a distinct political mission. *The Gaither Report* that served to introduce the Ford Foundation Programme runs as follows:

> "As the tide of communism mounts in Asia and Europe the position of the United States is crucial. We are striving at great cost to strengthen free peoples everywhere. The needs of such peoples, particularly in underdeveloped areas, are vast seemingly endless, yet their eventual well-being may prove essential to our security. To improve their living standards they must import and use knowledge, guidance and capital. The United States appears to be the only country able to provide even a part of the urgently needed assistance."

The political purpose has been served. The import of knowledge and guidance has borne the desired fruit. The western theories remained largely unassimilated. Communication of western knowledge has not gone far in understanding the real social process here at work. Nor has it been of much help in developing a correct understanding of the global situation as the views of most of our social scientists were considerably coloured and shaped by values of rationality of western colonialist and consumerist culture. Our servility has reached its zenith. The Indian social scientists have been practically disarmed. Is it a fact that we do not have the power to decide our own fate? As facts suggest, we are yet to write a theory of social change relevant to our context, taking comprehensive issues into account.

The Ideological Baggage

From the days of Macaulay's *Minutes* it was clear that the purpose of colonial education was to create a class of Indians who would remain subservient to the colonial rule, always identifying its own interest with the perpetuation of the British rule in this land. Another purpose was to create a class of clerks and lower level bureaucrats for the sake of running the administration in an alien land. Nothing to worry if by providing support to learning western theories of social science we were expected to serve in a similar way the neo-colonial interests of the as yet unchallenged superpower, the United States that is. By a simple extension of the imperialist logic, now because the indebted countries are being asked to abide by the rules of the *Washington consensus* there is practically no barrier in existence to the free play of market forces even in the most remote corners of the globe. In the name of creating a level playing field for the foreign competitors, governments of the poorer countries demolished all restrictions on imports from abroad so that

their fledgling industries were forced to down their shutters and leave the playing field altogether; peasants of Third World are being pushed out of agriculture unable as they are to face competition with subsidized agricultural producers of the advanced industrial economies. Now again in the best interests of the workers and employees in the public as well as the private sector they are being asked to accept cheerfully all the arrangements for an easy *hire and fire*. The neo-liberalist logic was woven to safeguard and further the interests of global corporations and FIIs; and without allowing for any delay the influential section of Indian economists discovered the logic of raising the level of country's efficiency in pursuance of the very same logic. The government was happy to announce that neo-liberal measures were taken in the best interests of the country as advised by the experts and if they happen to have similarity with the suggestions of the World Bank it was just a mere coincidence.

Under the neo-liberal dispensation most of our social scientists having a critical bent of mind have been co-opted by the system. A good number of them have turned overnight into worshippers of Mammon. In their judgment, the only way out of the present impasse is in the inflow of foreign funds. They discover rationality in every shade of governmental wisdom that "*there is no alternative*" to "sovereignty of global markets"—no alternative to neo-colonialism, which is neo-liberal economics enforced by finance capital and imperialist power. Egalitarianism in any form is rejected in this scheme as something trash and an irrational dream of the Utopians.

The government media too in recent times have joined hands with the global media to propagate the merits of market economy to make people believe that free market is identical with the competitive market. Circulation of the concept of market sovereignty ignores at least two important issues.

One is exclusion in wide areas of the Third World and the other is the undermining of the market by state subsidization and monopolistic developments. Majority of people in the underdeveloped area in the world economy eke out their livelihood from subsistence production. Asking them to reproduce the conditions of their existence accordance to the rules of "sovereign capital market" is indeed a matter of joke. Even in Russia after two decades of unbridled of capitalist progress free market rules operate only in the mafia-ridden cities and that too by denying the workers their wages for months. In the developed capitalist West also operation of 'free market' rules is hindered by monopolistic developments and protectionist care of the state. Above all, the capitalist globalisation process itself distorts the market relation and fair competition in favour of the hegemonic domination of the United States.

Social science analyses which appear in newspapers and electronic media deliberations cannot be expected in most cases to lay bare these issues as it goes against the class interests of the media magnates. The basic truths are not properly communicated to even the students of social science disciplines. They are not offered any chance to know that social science analyses are not neutral. The implicit and explicit assumptions embedded in a particular study reflect specific ideologies. This applies equally to neoclassical economics that underlies neo-liberal economic policies. It is not easy to reveal the ideology behind any theory but unless the difficult task is handled properly, the dissemination of science remains incomplete. Rather in the name of science, un-science is communicated.

Let us take up at some length the neo-classical economics as it underlies the ruling politics of the day. In neo-liberal economics the basic unit is individual who is governed by no other consideration than self-interest. The assumption of rationality of the individual is that he/she avoids pain and seeks pleasure; the rational individual seeks to maximize benefits in a given situation. The free market, we are told, enables everyone to maximize benefits. Then with the help of the essential proposition that the whole is the sum of the individual parts, the neoclassical scholars argue that state interference with the working of the market stands in the way of everyone's maximizing benefits. From this position the neo-liberalists conclude that state control over capital is socially harmful and regulatory power of the state needs be curbed but the power of the state to intervene in economic matters is welcome in the interest of capital. The ideology behind the neo-liberal theory is then no more a mystery. It is simply one of allowing capital a free reign. In the wake of the Great Depression in the early 1930s, cases of market failure caused the retreat of neoclassical economics. It is in this context that the Keynesian theory of facing the crisis by stimulating aggregate demand by means of state's investment gained currency. In the post-war world, the capitalist economies experienced undreamt prosperity, thanks to the remarkable technological progress achieved in the 1930s and 1940s, coupled with fall in the terms of trade for primary products. In this Golden Age of capitalist prosperity welfare-ism gained ascendancy. But in the early 1970s that Golden Age came to an end; price of primary products, especially oil, began to rise and the intensity of capitalist competition put an end to welfare-ism and Keynesian economics by pushing neo-liberal attacks--on social programmes, wages

and working conditions-- to the front. This is how neocolonialism appeared on world scene. Ideological compulsion of both the Keynesian and neo-liberal economics is to try in their own ways to make capital happy. Only the application of the theories calls for different measures because of the different perspectives in which they were born.

Without elaboration of the processes at work when our students are asked to have a look at the neocolonialism at work in depth, most of them are at a loss to understand why the post-colonial society is yet to free itself from the yoke of colonialism. Here lies the essential role of social scientists with positive social commitment. It is heartening to note that in the prevailing dismal state they have come forward to guide our students in understanding the laws of social dynamics. The students are urged to realize that (i) understanding this world is not enough, (ii) they should have the courage and initiative to transform it, and for this purpose it is necessary for them to realize that the capitalist globalisation is not the final stage of evolution of human society; there is alternative to it. The alternative lies in endogenous development by de-linking with finance capital; by promoting cooperation in place of aggressive competition; and by upholding community interest in place of self-interest of individuals.

No Scope for Despondency

Has social science education altogether failed to serve the interests of peoples of this land? Even if it has failed in some sense, it need not carry an altogether dismal note. Notwithstanding its limitations the existing system of education has thrown up some really talented scientists who have got the extra-ordinary stamina of swimming against the current. For this situation to have been made possible, credit certainly goes to a significant group of really worthy teachers who uphold the spirit of independence of thinking and whose sense of responsibility is beyond question. Shorn of traditionalist approach, these great figures of mature culture and high intellectual capabilities have remained in this land of ancient civilization worthy successors of such great teachers who could be firm enough when circumstances so demanded. They have inculcated in the students the Spinoza spirit, the spirit of "the most impious atheist" and rationalist that ever lived upon the face of the earth.

013 RAJU, C.K. (Center for Studies in Civilizations and Inmantec**, New Delhi**). SWARAJ IN SCIENCE EDUCATION.

Mathematics and science as currently taught in Indian schools are not universal and not even secular: some of what is uncritically taught is actually European ethnomathematis and tainted with post-Crusade theological beliefs (which theology derived form the compulsions that arise when religion is mixed with politics and warfare). This was wrongly declared to be " Universal" by Europeans who were mostly ignorant of other cultures, and also wanted to suppress them to achieve world dominance. During colonization, this "universal" system was imposed on the rest of the world partly through church-motivated genocide, and partly though Western education: it helped to colonize minds and to generate a sense of inferiority among them. This education created a comprador class dependent on the West, and which, Following man Macaulay, internalized Western education and a sense of inferiority to the point that it was unable to see things from and non-western perspective. Hence, this system of Western education was perpetuated even independence.

These process are particularly important for mathematics and science education. Capitalism generates information poverty; a capitalist society is so organized that most people necessarily do not understands mathematics and science; therefore, the curriculum and the contents of texts in these areas are solely decided by a clique of " experts" The "expert" are appointed by non-expert bosses who cannot themselves judge expertise; nor do they try to assess the practical contribution of these " experts" to Indian People; instead they rely on marks of social approval or other certificates form the West, or on common is social approval from the West. Therefore, it is not surprising that the "experts" advice resulting from this process can mostly be summed up by the 3-word formula "ape the West" This self- perpetuating formula is a guaranteed recipe for the permanent inferiority.

While the National Knowledge Commission (NKC) has correctly identified mathematics

education as a priority, it too fallen back on this old formula of "aping the West" for it followed the same process. (Incidentally), aping the West, brings in theology into mathematics, and that is exactly what makes math difficult, as I have argued in an earlier meeting). In fact, the exact opposite of "swaraj" is the primary requirement for a society of knowledgeable people (as distinct form what NKC rhetorically calls a "knowledge society") for true knowledge requires the freedom to explore fundamental, and can never be obtained on blind trust.

Hence, the NKC recommendation is likely to result in what I have called Macaulay 2: the moulding of Indian minds to suit the cheap-labour requirements of the West once again. Regardless of the megaprofits that some people evidently hope to reap, applying the mental shackles of "soft Power" to large number of potential workers through such "education" is an demeaning as the physical shackles of the slave or the coolie trade (which also involved mega profits for some). Further, even when the advice of those "experts" (to ape the West) has been publicly shown to be country to the basic requirement of secularism in the Indian Constitution, if they persist in that advice, and are not even able to defend their position publicly, they **must** be made accountable for their advice, though criminal prosecution if necessary, for irresponsibly propagandizing large numbers of school children in a manner contrary to the Constitution.

To achieve swaraj in science education, both mathematics and science teaching must be reoriented towards practical benefits to the people, and away from western theology, and the yardstick of Western social approval. Considering how the West has exploited us since the 18^{th} c., it is foolish to imagine that its social approval is oriented toward our benefit rather than our exploitation. Education must free the mind, not enslave it. Accordingly, it is foolish to imagine that its social approval is oriented towards our benefit rather than our exploitation. Education must free the mind, not enslave it. Accordingly, it is time to reject the carrot of BPO/KPO jobs and move towards dismasting the Western system of education in Indian in the interests of the vast majority of Indians. China and Japan did not have the "advantage" of English, but in economic term (or in technology) both have done much better than us.

As a first step we must do away with the associated racist history of science which was fabricated to inculcate a sense of inferiority through abject falsehoods (which are today propagated by NCERT texts, but for which the authors of those texts have been unable to produce primary evidence despite repeated demands since 2007). Compared to "saffronization" of history, the present-day history of science is a truly "world-class" distortion of history form the fanatical times of Crusades and the Inquisition,

Along with a change of history, there must also be a change of philosophy. The non-secular and non-universal aspects of mathematics and science, whtich have been explicitly identified in recent publication, must be promptly eliminated form the school curriculum. The constructive alternatives (e.g. of zeroism and calculus without limits) would be explained and the related experiments in education world be reported and discussed in greater detail in the panel on history and philosophy of science in science education. It is only through innovation and exploration of alternatives, and not by aping that we can hope to produce genuine leaders for tomorrow.

PLANERY IV

THE NEW PARAMETERS OF CHANGE IN SCIENCE EDUCATION

014 BHARTI, OMESH KUMAR (Set-9 Block No-1, 45-Club **Shimla171001**)

. BREAKING THE BLOCKADE TO ACCESS A CHEAPER VACCINE IN INDIA.

Rabies have been one of the most dreaded diseases leading to painful death in human beings. Globally around 55,000 people die of Rabies and of them 20,000 die in India alone. The discovery of nerve tissue vaccine (NTV) was a great savior for the animal bite victims and served the purpose for many years. Later in 2004 the use of this NTV vaccine, that used to be given free, was stopped by the supreme court in the country citing some (rare) reactions but without bothering about the fate of the million of poor people who were going to die for want of an affordable vaccine in the absence of a NTV.

In my brief clinical carrier I myself saw such cases that, for want of the cost, did not get the vaccine and died due to Rabies, a recent case is just two months back in district Hamirpur of Himachal Pradesh.

With supreme court banning the NTV, it was a celebration time for many private antirabies vaccine manufacturers as there was acute shortage of the vaccine all over. The champions who helped these companies put up a strong case for stoppage of NTV did not bother either to look for an alternate that is affordable or ask these companies to allow intradermal use of the vaccine like they were doing in other foreign countries.

The cost of one complete course of antirabies vaccine (ARV), is around 2220/- when given through an intramuscular route but the costs comes down to Rs. 370/- when antirabies vaccine is given Intradermally, five times less.

The WHO recommended the use of cost effective intradermal regimen (IDRV) in 1992 and same was introduced in Thailand, Philippines and Sri Lanka subsequently by 1996. In India many NGOs demanded that the IDRV be started in India as well but powerful vaccine lobby along with the corrupt officials did not allow this to happen while thousands were dying a painful death.

When the pressure to start IDRV mounted, the lobby invented a noble way to prevent the introduction of a well tested intradermal route saying that first the trials for efficacy and effectiveness of intradermal vaccine be done in India before giving any approval to the IDRV. 10 years after the cheap Intradermal route of antirabies vaccine was approved by WHO, Indian government ordered the trials to be conducted by ICMR in the year 2003-2006. Now the efficacy was proved beyond doubt but the drug controller dragged its feet to block the implementation by putting an arbitrary ceiling of 50 patients, if someone wants to give intradermal antirabies vaccination in India and that too only after the vaccine manufacturer write on its level that vaccine is fit for intradrmal use and level should mention "for IM/ID use", which the companies were not willing to do. No timeframe was decided to ask manufacturers to write on the level nor the government vaccine manufacturers were asked to expedite the amendment to the level of the vaccine to facilitate easy accessibility for the poor patients.

Again the winners were the vaccine manufacturers and the Lobby they were feeding to block the access to a cheaper vaccine.

After many protests, the DCGI lowered the limit from 50 to 10 patients, if someone wants to give IDRV, making again difficult to gather these many patients to start IDRV. It was for the first time that DCGI was deciding the number of patients for use of a vaccine rather than the route and potency of a vaccine. The same DCGI office has allowed the marketing of highly costly vaccines like Hib, Pneumococcal and Monovalent polio vaccines based on the trials conducted outside the country and is still allowing such drugs and vaccines that have not been tested or undergone field trials on Indian populations.

While DCGI office was dragging its feet to give permission to use intradermal antirabies vaccine for

anybody who needs it, a courageous man Dr. M.N.Siddiqui alongwith the government of U.P. started first antirbies intradermal clinic in the country on May 19th,2006 in U.P., and then there was no looking back. Now already nine states have started IDRV and many are going to start it soon. More than a Million doses have been given intradermally till date and millions of rupees of poor patients saved in the country.
The nine states to start IDRV are U.P., Orrissa, A.P., Karnataka, W.B., H.P., Kerala, T.N. and Uttrakhand alongwith a clinic each in J.J.Hospital Mumbay and at Ganiyari village clinic in Bilaspur district of Chattisgarh.

The mechanism of action of intradermal vaccine is that it is directly presented to the immune system (Axillary lymp nodes) and does not undergo dilution in the blood as is the case in intramuscular dose, therefore a small amount of vaccine given intradermally is enough to produce the desired immunological response. Because the volume of the vaccine used for intradermal use is one fifth of that of intramuscular use, therefore cost of IDRV also comes down to one fifth of the cost for intramuscular use, because the vaccine used for IDRV is the same that is used for intramuscular use.
With more and more states opting for the intradermal route, pressure have started forcing more and more companies to come forward to write "IM/ID on the level" and two of the vaccine companies have made vials for ID use and more are assuring to do so soon.

Million of rupees of poor patients and the government have been saved since the IDRV started in India and more than a million doses have been given inradermally without a failure.
Still a lot needs to be done, as the government and companies are still not serious to promote IDRV e.g. Delhi government can save more then 45 Crores annually by shifting to IDRV from IM route and money saved can be used to provide free Rabies immunoglobulins to save lives but there is laxity on this front and nobody is ready to take the responsibility. Similar is the case with other state governments that have not yet started IDRV.

In Himachal in a short period of eight months we have vaccinated 2020 animal bite victims (8080 doses) and have saved more than 30 Lac rupees of the poor patients and hope to save millions when intradermal vaccination for rabies post-exposure prophylaxis becomes a routine in future. Also we are helping our neighboring states to start IDRV as early as possible to make the benefit of a life saving vaccine reach to the masses that is now available at affordable cost, already they have been made to wait for more than 16 years now and need not to wait more for the apathy of decision makers!

015 CHATTERJEE, KAUSIK And GHOSH ADITII Department of Education, (Satyapriya Roy College of Education, Salt Lake, Kolkata University of **Calcutta)**
. CONSTRUCTION OF A SCALE FOR MEASURING SCIENCE TECHNOLOGY LITERACY.

Science technology literacy [STL] is a novel concept that weaves knowledge and awareness of science with its impact on society and societal needs. It implies that the major tool of societal problem solving is science. This perspective should form the framework of science education. Clearly this is a fresh approach to science education.

The investigator, who is based in West Bengal, perused the three most prevalent boards of secondary education and arrived at common content area. He also scrutinized the different set of objectives of science teaching and arrived at instructional objectives of STL which were expressed in behavioural terms .He then matched items from the common content area to these objectives. The resultant list of items was validated in several ways. An appropriate scoring system was initiated and the reliability of the test was found to be acceptable. Pilot administration of the test served to ensure further exactitude.

016 JAIN, SATISH K. (Centre for Economic Studies and Planning, School of Social Sciences, Jawaharlal Nehru University, New Delhi- 110067). ON SOME IMPEDIMENTS TO AND PREREQUISITES FOR RESERCH

The purpose of this note is to discuss certain factors which have important bearing both on the quantum and quality of research but are not discussed often, some of them rarely, if at all. Those things on

which there is a broad consensus that they are con- ducive for research will not be dealt with here. These consensus items include, but do not exhaust, library facilities, laboratory and other infrastructure facilities, and appropriate salary scales for researchers for providing the right kind of incentives.

Although not necessary, it would be helpful for the discussion that follows if one dif-ferentiates among different kinds of research. The most common kind of research is what can be termed as incremental research. An example of this kind of research will be the demonstration that an existing theorem can be proved with assumptions weaker than the currently employed; in other words a work which generalizes an existing theorem. A con-siderable amount of research that is done falls into the category of exploratory research. Within the existing framework of a theory some new idea may be introduced. The author of the idea as well as others then might explore through a series of papers the implications of grafting that idea within the existing framework. If these explorations are unable to establish the usefulness of the idea, in all likelihood it will be given up; otherwise it would be incorporated within the theoretical framework. A third category, the methodological and philosophical research, deals with the questions of relevance, delimitation of the theo- recital concepts, method and limitations posed by the theoretical structures. The level of expertise and knowledge of the subject required for this category of research for obvious reasons tends to be considerably greater than the first two categories.

Even an external critique of the theories and structures of a subject requires high level of expertise in the subject. Formulation of ideas, theories and structures with a potential to transform or radically expand the subject falls into the category of fundamental research. Although the impediments and prerequisites that we are going to discuss impact on all categories of research, they do it differentially for different categories.

In the context of factors which have the most significant bearing on research the sym- biotic relationship between teaching and research turns out to be of crucial importance. Competent teaching leads to a certain amount of incremental research in a natural way. If a certain theorem is taught as part of the curriculum and the theorem happens to be such that its conclusion is derivable from a weaker set of assumptions compared to the set currently employed then sooner or later this fact is bound to occur to some competent teacher or the other. It is in the course of constructing examples for elucidating an idea that one might discover the boundaries within which the idea is appropriate or relevant. Apart from competent teaching resulting in a certain amount of incremental research as a byproduct, it also acts as investment for research in the sense that it prepares a section of students for research at a later stage. If for some reason the instruction is such that it fails in this task then regardless of the presence or absence of other factors facilitating research the possibilities of research are reduced to a minimum.

Among the factors relating to the education system which are relevant from the re-search perspective we discuss below the three factors which are especially important. The first one relates to the organization of the school education. A dual schooling system where excepting the children of the well-to-do the rest go to schools where the quality of instruction happens to be at best indifferent results in a section of the children not getting proper education at the school stage. If the percentage of the well-to-do people in the total population happens to be small then a dual schooling system will lead to most children not getting proper education. As the superstructure of higher learning rests on the basic school learning, the children who do not receive proper school education essentially become unit for higher education regardless of intrinsic intelligence levels. Consequently the pool from which the future researchers will be drawn is in general smaller under adual schooling system than under a uniform schooling system. In general this will lead to deterioration in the average quality of researchers as well as in their numbers.

For research to flourish in any subject a reasonably large base of people with basic competence in that subject is required. Consider for instance the case of a researcher coming up with an interesting idea. The implications of the idea can be explored prop-erly, with a view to accept or reject it, only if there is an adequate number of persons in a position to do so. Even if someone has come up with an idea or theoretical construct with great potential, in the absence of a large base it is improbable that the potential will be realized. It is often the case that a potentially great idea or theoretical structure when presented for the first time lacks precision and is not free of flaws. It is only through the sustained incremental research that the idea or the structure acquires greater precision and relevance. Without there being a reasonably large

number of persons with basic com- petence in a subject there does not seem to be much possibility of serious research in that subject. Thus any factor which prevents a large base of persons with competence in at least one basic discipline from emerging should be construed as an impediment to research.

Like the dual schooling system, certain kinds of curricula can also lead to shrinkage in the number of persons with a potential to acquire expertise in a subject. If the school curriculum emphasizes learning by rote and deem phasizes learning of concepts and ana- lytical thinking then, excepting the very few whose intelligence levels are so high that they can overcome the handicap of not learning the basic concepts in school either by learning on their own or learning at a later stage, the students in general will not be equipped for research at a later stage.

The question of curriculum is exceedingly important, not just from research perspec- tive. Given the fact that the universal school education is not only highly desirable in itself but also increasingly necessary in the context of major transformations taking place in the world, an inclusive approach to school education is crucial. What is meant here by an inclusive approach is that the school education must be so structured that it fulfils the needs of different categories of students appropriately. There are of course certain things which everyone needs to learn in order to have a meaningful social existence. But there are many more things which require differential applicability. One main function of school education should be to help the students develop their innate creative potential. As different individuals have different interests, inclinations and abilities, the education must be such that it is able to help students pursue their varied interests and realize their potential in whichever direction it may lie. The adoption of an inclusive approach in the context of curriculum would imply that while at one extreme it must contain material which everyone needs to learn, the lowest common denominator; at the other extreme it must also serve the purpose of those who have an analytical bent of mind, are interested in learning the subject systematically rather than as a collection of facts and principles.

Marking or grading, if the marking/grading system is such that on the basis of a stu- dent's marks/grades by and large one can make a reasonably accurate assessment about the student's strengths and weakness, then a moment's thought will make it clear that such a system is not conducive for the existence of powerful networks. If marks/grades are reasonably reliable signals, and are recognized to be so, then networks will find it difficult to appoint and promote people with low marks/grades. On the other hand if the system becomes such that marks/grades have little relationship with the intelligence and performance, and are perceived to be such, then networks will be able to appoint and promote whomsoever they want to without any fear of public exposure and consequent criticism.

In this connection a particular societal function which is performed by a normal and properly working marking/grading system should be noted. Examinations serve many purposes. One very important role that the examinations perform is that, through mark sheets or grade-sheets as the case may be, they convey relevant information to many other individuals in the society. Other individuals in the society by making use of this infor- mation economize on their search costs. In the absence of examinations providing useful information not only would the information and search costs increase tremendously but the kind of job-person matchings which would materialize would be much inferior com- pared to what would materialize when the information contained in examination results is useful. It is clear that for examinations to perform the economizing-on-information function the examination results must have adequate and reliable informational content.

If the examination paper is so difficult that excepting the highly gifted few no one else can obtain even passing marks, information provided by such an examination is not going to be particularly helpful. Similarly an examination paper which is so easy that excepting those with learning disabilities everyone else can solve the paper in its entirety without any difficulty is going to be as unhelpful in providing useful information as the previous one. Information-revealing function is only one of the purposes. There are several other important functions which examinations perform. For most of these other functions as well it can be argued that bunching at the either extreme would defeat the very pur- poses which examinations are supposed to be conducive for. Relative grading which can solve the problem of bunching is a bad idea in most contexts because of its undesirable consequences; in the context of school examinations it must be

considered totally unacceptable. A much superior way is to attain the objective through syllabus; a syllabus such that while on the one hand it has all the things which are thought to be necessary for one's education, on the other it also contains a systematic, logical and coherent development of the subject which in its entirety only the very bright would be able to complete. Such a syllabus, while fulfilling the requirement of inclusiveness, would also in the most

Natural way result in a dispersed grading of the students, more accurately reflective of differential abilities and interests from the perspective of a particular subject; and thus providing superior quality informational input for all those search contexts where school examination results are used for screening or selection.

To sum up, this note has argued that the two most important determinants of quan-tum and quality of research are the size of the set of people with basic competence in at least one discipline and the nature of education and research establishment with respect to the key characteristics of freedom and decentralization; and that these two determine are related. The size of the pool of people with the required competence in at least one discipline depends on the nature of the education system. If the average competence of teachers is high, then one can expect the size of the set of competent people to be large; otherwise small. High average competence of teachers gets reflected in curricula which emphasize conceptual and analytical clarity and in discriminating and informative evaluation; low average competence results in curricula in which learning by rote is em- phasized and in an evaluation system which is poor in discriminating and in providing relevant information. One of the major causes of low average competence of teachers is the existence of networks. The existence of networks reduces quantum and quality of research by lowering the average competence levels on the one hand and by silencing the independent academics on the other. The argument of the note can also be summarized by saying that a low-level research equilibrium is characterized by the existence of power- full networks motivated by non-academic objectives, low average competence of teachers, curricula with low analytical content, an evaluation system with low correlation between grades/marks on the one hand and intelligence and learning on the other, and impedements to free scrutiny of ideas. On the other hand a high-level research equilibrium is characterized by the existence of weak networks or their complete absence, high average competence of teachers, curricula with high analytical content, an information-revealing and discriminating evaluation system, and a free and decentralized academic environment.

The most important policy implication that follows is that a society caught in a low-level research equilibrium and desirous of coming out of the trap must begin the process of reform with the education system

017 VAHIA, M. N. (Tata Institute of Fundamental Research Homi Bhabha Road. Mumbai- 400005). **BEYOND GRAMMAR:** TEACHINGPHYSICS AT UNDERGRADUATE LEVEL.

Teaching only the grammar of a language without teaching its literature would be unimaginable in any language. Indeed, in most languages, children are introduced to the literature before being exposed to its grammar. However, most physics teaching is restricted to teaching its basic grammar and problem-solving sessions are often restricted to helping understand a particular rule or point of the grammar of physics. We make a case that while teaching of grammar is crucial to understand the language of physics, teaching physics would be more effective if the literature of physics is taught along with its grammar. We give some examples to highlight this. Normally this task is left to popular physics books. Such books are not a part of compulsory reading and so, are ignored by students. Hence most students are not exposed to the literature of physics. We suggest that this needs to be changed and discuss some of the relevant issues.

1. Introduction:

Physics, as it is taught today, is generally a dry subject loaded with facts and information without any consideration to its manifestation in real life. It is like teaching only the grammar of English or any other language without exposing the students to the poetry and prose that make the grammar worth understanding in the first place. Indeed in the case of languages, more often than not, students are exposed

to the literature well before being given grounding in grammar and its subtleties. Even if one cannot follow the subtle nuances of a language in its fullest, a flavour of the subject is considered enough in order to invite student to explore the language in his own manner, through his own favourite writers and writing styles.

It is generally argued that the teaching of grammar is necessary since the grammar of physics is vast and complex and without a good grasp of the grammar, it is easy to apply inappropriate physical arguments to wrong problems. In any case physics deals with real world's problems and hence it is necessary to understand its grammar properly. Only after this can a student apply the correct grammar to understand a particular physical situation. The result is that all teaching of physics conspicuously avoids letting students give free reins to their imagination and discover the subtleties in their own manner. The result is a 16-year long lecture of increasing complexity of grammar, straight jacketed and taught in a remarkable monotone. It is only during the doctoral work, do the students apply the grammar to new situations and therefore enjoy the pleasure of creating a new piece of literature.

Physics textbooks from school level till even the master's degree consist of lessons or chapters on various mathematical equations that govern the physical world in a specific physical environment. For example, in mechanics, Newton's laws are discussed and a few problems or examples are given about how these equations are to be solved for a specific, highly idealised physical situation. Even at master's level, books dealing with electrodynamics and quantum mechanics follow the same principle, giving a basic description of a particular physical process or effect, sets out the equations which governing the situation and then specify the parameter limits or boundary conditions under which they are to be solved. Teachers quite conscientiously follow this procedure and even the best of teachers concentrate on creating a larger variety of problems for which the given solution may be used. There are plenty of books on Mathematical Physics discussing these mathematically stated problems and mathematical techniques that can be applied for their solution. This gives a good grounding in specifics of physical situations and their solutions but gives an impression that physics is a subject that analyses various physical environments under specific assumptions and simplifications and nothing more. Indeed even research is seen as a method of applying these or novel mathematical solutions to solve a particular physical problem, often under idealised conditions. Experimental science is seen as a logical extension of highly isolated systems being studied to check validity of theoretical formulations, or investigating a particular isolated physical interaction between objects in isolated conditions.

Some teachers and educationists have often discussed the question of using history, or giving historical background to these problems to humanise the problems that are being worked on and teaching of history of science is often suggested as a way of making physics more interesting.

However, the problem has persisted and only the best of institutions offer courses on subjects such as philosophy of science, which takes a more holistic approach to the subject. Most conventional physicists, however, consider philosophy to be a no go area for practicing physicists. Philosophy, it is believed, is meant more for students of humanities rather than an issue on which good physicists should ponder.

Normally the task of giving a more holistic understanding of physics is left to popular physics books. These books are expected to discuss general behaviour of a natural system, from origin of the universe, superconductivity etc. Such books take up a particular system and then discuss relevant physical ideas that contribute to understanding of the system and produce a more holistic idea of nature and role of physics. However, such books are not a part of syllabus and are mostly are ignored by students. The result is that a majority of students are not exposed to the literature of physics and find the grammar to be suffocating and constraining as well as dry and are discouraged from pursuing studies in physics.

However, any study of the best works in physics will show that people who work on more holistic aspects do some of the best work in physics. They work with several physical concepts, ideas and technologies developed for different purposes and put them together to get a more detailed understanding of a physical problem. Such an approach alone gives new insights into the working of nature instead of simply working out increasingly finer details of a specific problem. Indeed even when theories such as the

theories of relativity etc are worked on, most of the work is in the field of how they affect other physical systems. Such systems are often far removed from the problem for which they were originally developed.

In fact, I really doubt how many physicists really remember their physics by the equations. More often than not, they remember or have a mental picture of various physical environments and the physical processes that are involved in those situations. For writing the equations, they either use analogies or quite often go back and refer to the text books in which the relevant equations are written down. What they carry with them are the pictorial images of the physical environment. This is not to belittle the importance of mathematics and the exact and generalising capabilities that writing and solving equations provides, but to simply state that though physics is *taught* in this manner, it is *learnt* more in its geometrical format. The case that we wish to make is to suggest that at least at the initial level, physics may be better conveyed by visualisation and integration along with a more realistic mapping to real world.

So clearly, while the present approach to physics education produces good classical physicists, it often fails to inspire brilliant but wavering students who can be unnerved by the problem solving approach to physics.

We discuss a possible alternative or addition to the current style of implementation of physics teaching which not only teaches students how to solve problems in physics, but also *why* solve these problems and how these issues relate to the general working of nature.

2. Holistic approach

It is my proposal here to suggest a more holistic approach to teaching physics. The proposal is probably not new and a consensus of this kind is probably emerging. I am just giving words to these ideas. A good syllabus should teach the grammar (each individual idea, concept and its relevant mathematics) as well as its proper connectivity to the real world. The purpose of the teaching would be not only to teach the subject or idea (the grammar) but establish its proper context and relative importance in the overall scenario of our understanding of the physical world. The approach is not to humanise the subject by giving historical references, nor solve problems that only establishes the proper use of the grammar which are currently done quite satisfactorily and should continue. The idea is to help students realise that each set of concepts and ideas is filling a particular piece of jigsaw puzzle in the overall understanding of physical universe.

Also, it may be useful for a teacher to teach a subject to a specified level of complexity but leave the students with questions that require a higher level of understanding than what the current level of conceptual explanation can achieve, as some kind of 'points to ponder' questions. When initiating discussion on mathematical formulation, the ability of mathematics to bring out similarity of a process in different situation by similarity of formulation is rarely brought out. Simple harmonic motion and its appearance in a wide variety of natural processes is often not highlighted. Similarly, the fact that the nature of gravity and electrostatic forces in terms of their intensity depends on the square of the distance between the objects is mentioned separately. But even while discussing the planetary model for atoms, the size difference is not explained. The constant of proportionality in gravity, the universal gravitational constant is much smaller than the similar constant in the case of electrostatic forces. It is this difference that demands that for comparable magnitude of forces, the magnitude of gravitational masses have to be much larger than electrostatic charges.

To take one example, while teaching Newton's laws, few, if any teachers discuss friction in the same lecture. The result is that the counterintuitive nature of a body in uniform motion (when all his or her life the student has seen all motion come to a natural end) remains a poorly grasped concept whose real physical elegance remains obscure. The result is that students develop two parallel world views. One view for classroom states that a body remains in a continuous state of motion unless compelled by an external force. But for his or her personal life, any object when in motion, will come to rest and the distance at which it comes to rest depends on its weight and the relative smoothness of the contact surfaces. Often these contradictions give physics the label of a difficult subject.

We give below some set of concepts that need to be discussed together. Clearly the list will be much larger than the one given here which is restricted by my personal experience. In the end we will give an example of the number of correlated subjects that can be discussed based on a single simple thought experiment with little or no equipment, except the imagination of the teacher.

3. Some examples of holistic studies.

1. *Newton's Laws:* While teaching Newton's laws, it is necessary to mention and at least conceptually discuss friction, which dissipates energy and makes Newton's laws counter intuitive. It is also important to point out that friction is an *electromagnetic* force and as such is critical for our existence – no motion is possible without friction. A discussion about lubricants may also be useful.

2. *Kepler's Laws:* While talking of planets it is useful to talk of long term instabilities. The impact of planets on the location of centre of mass of the system and impact of giant planets such as Jupiter which force perturbation on the motion of comets and meteorites and pull them in so that Jupiter becomes a giant vacuum cleaner of the Solar System is also interesting. Point can also be made about the failure of asteroid belt to coagulate due to the counterforce of Jupiter and a mention of Kuiper belt will certainly make the discussion interesting.

3. *Electricity*: It is important to mention how friction comes from electrostatic forces between atoms, it is never made clear that friction is a result of one of the four forces of nature and has got something to do with electrostatic forces. Use of electricity in brain wire connectivity is also important. How good conductivity allows metals to carry electricity but prevents them from being used as transistors also helps put the concepts of conductivity into perspective.

4. *Projectile motion:* While discussing projectile motion, it is almost always discussed in ideal conditions and limits posed by reality, such as air friction, are not discussed. It is also important that the Moon is also in a projectile motion with its x-axis component so long that it misses the earth completely and falls over. It is also useful to mention escape velocity and closure of universe in the same discussion.

5. *Law of fluid displacement and floatation:* The law of floatation clearly defines that what is important is mass and volume but not of shape of an object and the law, especially the displacement law can be used to weigh unusual objects as well as give an idea about its total volume, if density is known. This law therefore has several applications beyond the ones normally assumed.

6. *Gravity:* Gravity measures weight or gravitational mass, which *in principle* is different from the inertial mass of Newton's laws of motion. That their values are mathematically equivalent is one of the mysteries of nature. It is also interesting that gravity can also bend the path of mass-less objects such photons.

7. *Phase transitions:* The example of water to illustrate the phase transition is an interesting one. But water is probably the only bad example with its Triple Point, where all three phases can exist in equilibrium. More importantly, the density of water *decreases* when we move away from the Triple Point. Hence it is also interesting that ice is the only solid that floats on its liquid, forcing water to freeze top down. It is important to discuss the difference between vapour, steam and gas.

8. *Atoms:* While discussing the structure of the atom, it is important to point out that the volume in which the mass of the atom is concentrated is only 10^{-9} of the volume of the atom. While discussing the 'solar system' model of the atom, it is important to point out its *approximate* nature. It is important that the simile works simply because of the fact that the nature of gravity and electrostatic forces is such that they both fall as the reciprocal of the square of the distance and the size scaling is due to the difference in the value of the constant of proportionality. It is also interesting that forces are central to nature and that matter is an important probe for, as well as manifestation of forces. A transition from atomic nature of formulation to bulk nature of matter

occurs at size scales of about 1000 times the atomic size. In intermediate sizes, nano material provides a window to the nature of transition from Newtonian to Quantum world. While studying atomic sizes, the fact that the energy of the probe is comparable to the item being probed produces some important effects.

9. *Elasticity and Young's Modulus:* Intermolecular separation and induced change in it by external force. Relative size of intermolecular forces compared to the deforming force. Amplification of microscopic quantities into macroscopic world.

10. *Light (especially at B Sc level):* It is impossible to over emphasize the fact that the speed of light is constant in a given medium *no matter what you do in terms of inertial frames of reference.* Also, the velocity of light in a medium changes due to the electrostatic drag on the electromagnetic field of light. It also proves that light is an electromagnetic radiation. Note that there is no way of *proving* that light is an electromagnetic radiation except by the fact that the velocity of light is one of the constants in Maxwell's equations and that accelerated charged particles produce light! Its medium-free travel coupled with its *sensitivity* to the medium is also an important aspect. Its impact on universe at high speeds and space-time contraction are also important. Inability of light to change speed and the consequent red and blue shift with changing energy and frames of reference are some other aspects of the constancy of speed of light.

11. *Escape velocity:* A black hole is an object where escape velocity is greater than the velocity of light. But why can't one have black holes of ordinary matter? The fact is that the amount of matter at normal density that has to be piled up to make a black hole of ordinary matter makes it impossible. Objects composed of normal matter are self limiting and degenerate into unusual objects. Also, escape velocity is a concept that can be applied even to diffuse objects and it varies linearly with mass.

12. *Viscosity and surface tension:* A flat piece of paper with its surface placed on water permits it to float while placing it edge-on makes it sink. It is interesting that viscosity is a bulk property but surface tension is due to unbalanced surface electrostatic forces. As a surface phenomenon, floatation and flowing ability of different liquids is different. How viscosity affects diffusion of dissolved and suspended material inside the fluid is also important. Its relation to size scale, e.g. water is a lubricant for meter size objects while it is too viscous for micro machines are other important topics.

13. *Radio activity:* It is important to explain penetrating radiations and the reasons why they are penetrating radiations. Ionising radiation, damage to molecules and problems of cancer are some of the issues that should be taken together.

14. *Kinetic theory of gases:* The ultimate validation of this theory in terms of laser cooling makes the point of kinetic theory clear beyond question. Also, Maxwell's demon in real life, magnetic field also adds an interesting dimension since it is crucial in keeping Sun's corona at a temperature almost 100 times the surface temperature, violating laws of thermodynamics and energy transfer!

15. *Inclined plane:* While inclined planes and the orthogonal nature of the force vector are discussed together, it is important to mention how rolling friction allows the limits given by friction to be circumvented. It is important to talk of roll down in this perspective as also the direct change of potential energy to kinetic energy, and how the reversal at the bottom of a hydro electric power plant permits converting the kinetic energy back to potential (electrical) energy! Efficiency of such systems allows discussion on efficiency and related issues.

16. *Reflection, refraction, opacity of material:* Frequency dependence of reflection and refraction angles, role of free electrons and crystal structure in opacity also needs to be discussed together. The fact that these are due to velocity changes in media due to effect of electrostatic fields of the medium on the electromagnetic radiation needs to be highlighted. How the bending of light occurs

due to its demand of rectilinear motion and the splitting of light beam due to the frequency dependant nature of the entire process also need to be highlighted. In this context, Cherenkov radiation can also be discussed.

4. Classroom and thought experiment with a bucket of water.

For a typical open ended discussion in a classroom that can allow a teacher to bring out the large variety of physical processes in a real life situation, we take an example of a bucket filled with water.

A teacher can discuss the following physical processes by appropriate actions:

1) Potential energy and Kinetic energy: Lifting of the bucket on table and pouring of water (conversion to kinetic energy).

2) Transparency of small quantities of water and the opaque nature of large quantities of water – statistical nature of scattering. Its exponential nature. It dependence on wavelength. Change in opacity with impurities and temperature.

3) Density changes with temperature and pressure, compressibility of fluids.

4) Boiling, vapour pressure, steam and gas, its dependence on temperature and pressure and kinetic theory of matter.

5) Addition of soluble and insoluble substances, diffusion of matter, Brownian motion, effect on colour of water, density differences and its effect on floatation. Surface to volume ratios of powders and its consequences. Addition of oil and determination of upper limit on size of atom. Surface tension as imbalanced intermolecular interaction.

6) Heating and convective and conductive transport of heat in solids and liquids.

5. Conclusion:

We suggest that while teaching the grammar, a more holistic approach will give students a better idea about the nature of the subject and its relation to the working of nature than the current method of teaching. We suggest that this approach is applicable to all levels of physics teaching.

Planery-V

HISTORY AND PHILOSOPHY OF SCEINE IN SCIENCE EDUCATION

018 Lahiri Ashish (P-121,Kalinidi Housing street **Kolkata-700089**). AKSHAY KUMAR DATTA AND ISWAR CHANDRA VIDYASAGAR: PIONEER RATIONALIST EDUCATIONISTS IN BENGAL.

Raja Rammohan Roy (1772-1933) was perhaps the first Indian in colonial India to argue for a modern scientific education based on Baconian empiricist principles. Taking the cue from him, Iswar Chandra Vidyasagar (1820-1891) and Akshay Kumar Datta (1820-1886) went ahead with their programmes of inculcating a scientific temper among young persons. Both of them were agnostics and insisted that the Indian mind, steeped as it was in religious and metaphysical ideas, must turn its attention to understanding reality rather than arguing it away. In the teeth of stiff resistance from British orientalists, Vidyasagar, himself a legendary Sanskrit scholar, introduced Bacon's *Novum Organum* and John Stuart Mill's *Logic* at the Sanskrit College curriculum and pleaded for introducing modern mathematics. Instead of writing on religious leaders, he wrote popular biographies of scientists like Copernicus, Galileo and. Newton. Akshay Kumar Datta, a self-taught polymath *par excellence*, wrote numerous articles on science in Bengali, thereby building up a store of Bengali technical and scientific words some of which are still in use. His text books on physics, geography, moral science and other subjects were required reading for at least two generations. Aggressively anti-superstitious, he was the first person to write an empiricist critique of all the systems of Indian philosophy, drawing on history and philosophy of science. However, both ran into difficulties. Both the British colonial system of education and the Indian traditionalists stood in their way. Despite heroic efforts, both of them died in dejection. At the end of the nineteenth century religious revivalism was at a premium, despite some progress in formal science education. Nevertheless, their pioneering efforts at creating a scientifically aware society are continuing to bear fruit, particularly in developing non-formal modes of popularizing science and fighting obscurantism.

019 RAJU C.K (Center for Studies in Civilizations and Inmantec, New Delhi): PANEL ON HISTORY AND PHILOSOPHY OF SCIENCE IN SCIENCE EDUCATION.

When religion mixes with state, that manifestly influences history writing, and we have seen this happening recently in India. However, this proposition applies also to the Western history and philosophy of science as was brought out recently in a book, *Cultural Foundations of Mathematics*[1]

Briefly, during the religious fanaticism of the Crusades, a Hellenic origin was concocted for all pre-Crusade world-knowledge accumulated in Arabic books captured at Toledo. Late and obviously accretive texts were uncritically attributed in their entirety to theologically correct early Greeks, even when contrary to common sense and non-textual evidence. There is no serious evidence that figures such as Euclid or Claudius Ptolemy even existed.2 During the Inquisition (and the prevailing atmosphere of religious intolerance in the rest of Europe) this process of making the origins of knowledge theologically correct was carried forward, by claiming "independent rediscovery" by European sources. A well-known scandal here is the case of Copernicus,3 but, of course, there are numerous other cases. Later-day racist and colonial historians built upon this process of self glorification to arrive at the present shape of the Western history of science, which attributes almost anything worthwhile in science either to a Hellenic source or to later-day Europeans.

This motivation also impacted the philosophy of science: acceptable knowledge had to be theologically correct. Attributing the *Elements* to an unknown "Euclid" helped to reinterpret it in a way acceptable to post-Crusade theology. This reinterpretation of the *Elements* differed from its earlier Neoplatonic understanding (to which Origen's pre-Nicene theology was close) and is best understood4 as an adaptation of Islamic rational theology (*aql-i-kalam*), and al Ghazali's criticism,

to suit post-Nicene Christian theology.

This process of theological purification made mathematics metaphysical. That attitude persists in present-day formal mathematics which not only deprecates the empirical but is divorced from it, and hence is entirely metaphysical. This metaphysics involves an obvious religious bias: most theorems of present-day formal mathematics would fail if one used Buddhist *catuskoti* or Jain *syadavada* instead of 2-valued logic,5 or rejected deduction as unreliable like the Lokayata. Obviously enough, formalism cannot resort to empirical methods to decide the nature of logic, and even if it did, the outcome is not guaranteed (e.g. one might have to contend with quantum logic). Noticeably, this argument, which has
been around for a decade,6 has gone unanswered though it destroys a central tenet of Westernphilosophy of science along with the philosophy of mathematics.
For purposes of pedagogy, a more honest history and a less-biased philosophy is required to enable one to learn from the past. On the epistemic test, mistakes expose false claims of independent rediscovery. But such mistakes are also useful for pedagogy through the principle that "phylogeny is ontogeny". For example, Gerbert of Aurillac (Pope Sylvester II) imported "Arabic numerals" in Europe. Accustomed to the abacus and failing to understand the place-value system, he made a blunder. He inscribed the new numerals at the back of his old counters7 hoping that would help arithmetic along! Such mistakes help to understand the difficulties that today arise in the minds of children in transition from abacus to arithmetic algorithms.

Such mistakes abound. Clavius published elaborate trigonometric tables8 (remarkably similar to those derived by calculus techniques, and readily available for the preceding half-century to his Jesuit brethren in their Cochin college). However, Clavius did not know the elementary trigonometry needed to use those tables to measure the size of the earth (a critical input which could have solved thelongitude problem of European navigation).

Descartes (presumably in response to Pascal and Fermat who were enthusiastic about the imported calculus) stated9 that it was beyond the capacity of the human mind to determine the ratios of curved and straight lines (although this can be easily accomplished by using a flexible string, as was traditionally taught to Indian school children10). Galileo concurred and hence left it to Cavalieri to claim credit for the calculus. Apart from the cultural preference for straight lines, Descartes' and Galileo's strange objections to the calculus can be understood by the human mind only in the context of theological correctness: not only did they mistrust empirical procedures in preference to a biased metaphysics, they sought some imagined perfection or certainty in mathematics, and hence thought the

calculus involved supertasks. Newton's fluxions and Leibniz's differences attempted to assimilate the calculus to this European understanding of mathematics, and some of their mistakes were pointed out by Berkeley. These mistakes, and the religious beliefs (about the perfection of mathematics) which led to them, persisted at least until the present day theory of the continuum and limits, which relies on set theory to provide a metaphysical mechanism for performing supertasks.11 These mistakes are useful to understand why school children today find the calculus a difficult subject.

Against this background, the panel will consider the following questions among others. (1) Whose interests are served by promoting racist history through school texts? (Current Indian school texts display racist images of imaginary figures like Euclid and neither the authors of these texts, nor the Indian government agency responsible for publishing them have been able to respond appropriately to the repeated public demand for the primary evidence on which these historical claims are based.) (2) In a secular country like India, is it appropriate to continue teaching formal mathematics which has no practical value except to acculture the student into a religiously biased metaphysics? Specifically, is it appropriate to do so at the school (K-12) level where no choices are available to students? (3) Most K-12 math (arithmetic, algebra, trigonometry, calculus) originated in a non-European cultural setting. On the principle that phylogeny is ontogeny, the confusion in math teaching can be understood as arising because present-day math teaching retraces the trajectory of the absorption of these ideas in the West, and hence recreates the confusion that accompanied this process (of making mathematics theologically correct). This confusion can

be avoided by rejecting the cultural beliefs superposed on this mathematics in Europe, and going back to the original practical context in which that mathematics developed: Aryabhata's approach to calculus is far easier to understand and offers far greater practical value today (since it is better suited to the technology of computation) than the religiously tinted hence enormously complex approach of formal mathematics via continuum, limits and axiomatic set theory. Should math teaching, at least at school level, not be based on practical value as in the ongoing course on "Calculus without Limits"12? (4) If engaging with the philosophy of mathematics ("rigour") is a must, would it not be more appropriate to base math teaching on alternative, realistic philosophies of mathematics, such as zeroism, implicit in its developmental context?

020 UMA, SUDHIR (EKELEYA, **HOSNGABAD M.P**). HISTORY, PHILOSOPHY & NATURE OF SCIECNCE EDUCATION.

The traditional 'transmission' model of communicating 'scientific knowledge' treated the child as an empty vessel to be filled. The system was self-satisfied on the whole till Sputnik happened. The resultant soul-searching gave us versions of inquiry-based science curricula which were supposed to be the panacea for the lack of both scientific manpower (I don't think they worried about person-power then!) and educated citizens. However, the reviews of the effects of these curricula revealed disappointing results with changes being estimated at ~ 5% (I have to locate the reference for this). Two reasons for these results were easily ill-prepared teachers and ill-equipped schools. And we may suppose that these may be amenable to change with the investment of both time and money. But it took David Ausubel to point out a third reason – 'The most important single factor influencing learning is what the learner already knows.' So we had children drawing the weirdest conclusions from what seemed like fool-proof experimental set-ups!

The people who call themselves constructivists were at the fore-front of the research into what has been called children's alternate conceptions. And the maximum work seems to have been done in mechanics. So let me take an example from another field. Ruth Stavy[1] enumerates divers factors that influence children's understanding of the different states of matter*. According to her, the conception of liquid is clearest first while only rigid solids are initially classed as solids (flexible materials like aluminium foil and powders like common salt do not count). And even children who can correctly classify substances as solid / liquid still don't give explanations at the particulate level, but go by macroscopic properties like 'is hard' / 'can be poured'. The standard approach of giving only typical examples seems to reinforce the children's intuitive classification of aluminium foil and honey into a 'neither solid nor liquid' category.

The confusion here is also about what constitutes an explanation. The particulate nature of matter is a model that explains why milk needs a container while marble slabs can be stacked. The question why water is a liquid at room temperature is not satisfactorily answered by 'because it can be poured', but requires an explanation in terms of intermolecular forces and the average energy of the molecules at any temperature. But this difference is not always made clear to the students. Most of the experimental work done in schools expects children to draw conclusions from observations (or data) as if these follow in a direct and logical way from observations. For example, if the child is told that the glowing of a bulb in a circuit 'proves' that electric current is flowing, and not that electric current is a 'theory' that explains the lighting up of the bulb, the child is bound to get confused and not appreciate that theory is distinct from data. Further, if empirical generalisations (like Charles' Law and Boyle's Law) and theoretical models (like Bohr's model of the atom) are conveyed in the same way, then the child is not likely to understand the role of observations in establishing scientific knowledge.

Coming back to constructivism and its place in science education, while the need for taking into account the prior conceptualisations of the child is appreciated, the other contributions of constructivism as a philosophy[2] and in the field of pedagogy[3] are more contentious. Also, the positive contributions of constructive pedagogy have been used by others including the Progressive Schools with their Project

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* Language seems to make a difference too. In Hebrew, the same word 'nozel' functions as the noun 'liquid' and the verb 'pour'. So Israeli children seem to use the word 'liquid' earlier than English-speaking children.

Method. For example, Varma[3] lists an 'eight-fold way of constructive pedagogy' (Appendix A) which is no different from the principles that led to the development of the HSTP.

The Achilles' heel of constructivism (except for the radical constructivists for whom anything goes) is having to get the children acquainted with the vast body of scientific knowledge if the children are pected to construct their *own* knowledge from their *own* experiences. As an example of this conflict, I shall refer to another paper[4] from the book quoted above. This paper describes a constructivist's approach to the topic of rust – what is rust and what are the factors affecting rusting, and I shall focus only on the treatment of the latter.

The lesson-plan called for giving all the children some iron nails *three weeks* before the first lesson. The children were asked to take the nails home and keep them in a place where they thought maximum rusting would occur. They were asked to give reasons for selecting that particular location (one child put the nails on the floor of the shed at home because he had noticed that a spanner left there had rusted) in their reports.
During the first lesson, the children compared the nails kept in different places and arranged them in a display from the most to the least rusty. They then listed out the factors they thought were affecting rusting (water/rain, cold, salt, acids, dark, light, *etc.*). These factors were to be tested for in 'controlled experiments with fresh nails left under different conditions over the next six days.

The paper actually suggests three alternative routes which could be followed after the children had worked on their display:
1. Present the 'accepted science view' and relate it to the nails display. That is, the teacher could give the children the factors that actually cause rusting and then the children could check the theory with the results of their experiments.
2. Build the 'accepted science view' and relate it to the nails display. Here, the teacher could set up controlled experiments which would bring out the factors affecting rusting and the children could compare this with their display.
3. Take the information from the nails display and work from this towards the accepted science view. Here, the children would elicit from their display the factors that cause rusting and then proceed to test these factors under controlled conditions.

In the best constructivist tradition, the third route of getting the children to test the various factors is taken up. However, two points are to be noted in the further sessions. One, since the children don't list air / oxygen as one of the factors necessary for rusting to take place, or even iron, the teacher sets up tests for these two factors over the same six days and uses them for further discussions. Two, since the children don't factor in air / oxygen, their 'controls' don't take in variations of these factors either. So it seems that instead of following constructivism strictly, the teacher has to intervene at suitable junctures and guide the children to the accepted science view.

Going Beyond Enquiry:

The enquiry-method has its roots in the perception that the transmission method does not manage to teach science. But is something other than the enquiry method required to give children a feel of science? I would like to take a long quote from Joseph J. Schwab[5] in a book written in 1962 (reinventing the wheel seems to happen all the time):
Consider a student who has garnered the impression that science consists of inalterable truths. Five or ten years after graduation he discovers that many of the matters taught him are no longer taught, nor any longer used as knowledge. They have become obsolete and been replaced by other formulations. Unprepared for such a change, unaware of the operations of enquiry which produce it, the former student, now a voting member of the polity, can do no better than to doubt the soundness of his textbook and his teacher. In a great many cases, this doubt of teacher and textbook becomes a doubt of science itself and of professional competence in general. The former student has no recourse but to fall into a dangerous relativism or cynicism. He concludes that experts are untrustworthy, parading the doubtful as certain, or even that they promulgate particular views as true because it is to their own interest that people believe in them.

Consider a student whose learning has confused idealizations, such as the freely falling body, with

the real objects of which they are ideals. He learns to expect of the common-sense, real objects the behaviour which holds only for the ideal case. This behaviour is belied in actual experience. Again, the student has no recourse but to conclude that scientific knowledge is, somehow, false or inapplicable to reality.

Consider, too, the student who has never been taught to discriminate the conceptual from the physical. For such a student, a change in the formulation of scientific knowledge which he once learned is not only an instance of unexpected change in what should have remained fixed and certain; it is also an incomprehensible change. Since he does not know that some of the "things" taught him are not things but ideas, he cannot account for the sudden disappearance of all reference to them and he is still further confused by the new body of statements which refer to "things" of which he had learned nothing at all. The effect of this experience can only reinforce the impression that science is whimsical or mysterious and without relevance to the realities which count in life.

If, on the other hand, the curriculum illustrates with care and clarity the role of idealizations and conceptions in the construction of scientific knowledge and exhibits the growth of knowledge which takes place through the replacement of one body of conceptions by others, the student would see the ground for change and revision, and for the deviations of common-sense objects from the ideal objects of science.

He would see, too, that authority consists, not in possession of information, but in possession of competence in enquiry. Change in what authority says would no longer appear as a sign of confusion or mere change in fashion but as a sign of the progress of enquiry. The student could understand that to be true does not necessarily mean to be fixed and eternal; that what is said in one set of terms may give way to something else, not because the first was false or has become unfashionable but because it was limited. He could understand that a new formulation may arise and be more desirable because it encompasses more, in more intimate interconnection, than did its predecessors. Consequently, the event of change could no longer be ground for generalized mistrust of the soundness of scientific knowledge. (Pages 46-48)

So how is all this to be managed? Rosária Justi and John K. Gilbert[6] propose that the role of history and philosophy of science education would offer the scope to:

i) teach the students about the nature of science – as a cultural achievement as a result of human endeavour.
ii) utilise any parallels between the development of subject matter *per se* and the development of an understanding of that subject-matter by students – where applicable!
iii) develop students' capabilities for critical thinking – and
iv) develop a fresh approach to the structuring of content which will be more cogent than the present break-up into isolated themes.

Some approaches in teaching specific concepts are given by Douglas Allchin[7], Kevin C. De Berg[8] and Anton E. Lawson[9]. Allchin has used the concept of phlogiston to teach metals and oxidation-reduction reactions in addition to inducing discussions about realism and reliability and the historical development of concepts (Appendix B). De Berg has suggested an historical approach to the concept of work which clarifies the (force × distance) definition of work (Appendix C). Lawson discusses the issue of differentiating hypotheses from predictions while performing experiments and its implications for engaging students in open enquiries (Appendix D). Other studies also show that an understanding of the nature of science supports successful learning of science content.

Some other issues that need to be addressed are:

1) Content as in Number of Facts:

Steven Vogel[10] says Biology is usually presented as 'a mass of terminology, revealed truth, and thinly disguised inconsistency…'. The Physics and Chemistry textbooks may be better, but only in comparison. It helps if we are clear about what we are presenting 'facts' for, what it is supposed to lead to. For example, Keeton[11] describes the action of the various enzymes digesting proteins in great detail specifying the nature of action of pepsin, trypsin, chymotrypsin, endopeptidases, exopeptidases (carboxypeptidase and aminopeptidase) and dipeptidases. Then he goes on to say:

The chemical action of the various proteolytic enzymes has been described at some length, not because it is important for you to remember in detail what bonds each enzyme hydrolyzes, but because the proteolytic mechanism provides a good example of enzyme specificity and of the way enzymes often work in teams. If we had simply said that proteins are digested by pepsin, trypsin, and a variety of other peptidases, you would have had no indication of the elaborate interplay that characterizes these seemingly

commonplace processes.

Such an approach would have obvious implications for evaluation also. For example, if as in the CBSE board examination in 2007, the children are asked about the number of stars in the milky way, they are going to get bogged down in the details and will never get to appreciate the larger picture where all the discrete pieces fit together to make sense.

2) Technology *Vs*. Theory:

Normally, technological applications are tagged on to the discussion of theory. Like children are told about the working of an electric bell in the chapter on electricity or about the rear-view mirror in the chapter on optics. This residual role for technology does not bring out the complex interaction of the growth of technology and theories in history where the technology often preceded the scientific explanation. Things may have also been simple a hundred years ago where you could open up an automobile or a clock and try and figure out what various parts did and go on to understand the science behind the mechanism. These days, the interface between any machine and its user is designed to hide the complexity of its 'innards'. So what technology do we choose to cover? If we choose to teach heredity, do we go into the polymerase chain reaction and how that helps us to study DNA?

3) Logic *Vs*. Epistemology in Ordering Concepts:

Noretta Koertge[12] goes into the conflict between the logical development or ordering of concepts on one hand and the systematic development of these same concepts on the other. One of the examples she gives is that of Newton's laws that explain the motion of pendula, falling bodies, the motion of the planets and the regularity of the tides. Starting with the more general, but abstract, theories cut off the students from the empirical basis of science. However, the systematic development of concepts would not convey how science develops over time. An example which illustrates this confusion is the way the periodic table is presented to students. To a chemist, the table is a tool that summarizes a wealth of facts. But the student is given no idea of the painstaking analyses which went into deciding the position of the majority of the elements and enabled the prediction of the existence of a few other elements. Therefore, in teaching the periodic classification of elements, we have to be clear about what our aims in teaching it are.

4) Role of Original Papers:

Both Gerald Holton[13] and Joseph J. Schwab[5] talk of the benefits of using original papers with students. Holton gives the example of a 1935 book *A Source Book of Physics* by William Francis Magie which had extracts, one to ten pages long, from original publications. Schwab suggests using either the original papers or edited versions (to make the language comprehensible) and gives the example of using Mendel's paper to teach genetics. He gives two advantages of using original papers:

1. 'They afford the most authentic, unretouched specimens of enquiry which we can obtain. All other accounts of enquiry must consist of abstraction (often selective), interpretations (often biased by favoured "philosophies" of science), and commentary on these materials.'

2. 'The second advantage of original papers consist in the richness and relevance of the problems they pose for enquiry into enquiry. Each individual paper poses the problem of discovering its basic parts (problem, data, interpretation, and so on). Each poses the further problem of discerning the relations among these parts: why the data sought were the appropriate data for the problem; why data actually acquired depart from the data sought; what principles justify the interpretation of the data.

The individual paper poses problems of evaluation, as well. Are the actual data as appropriate as the reporting scientist considers them to be? What additional assumptions, beyond those noted by the author, are involved in his interpretation?'

Schwab obviously thinks that depth of coverage is better than breadth! And I should add a rider that this is proposed for higher secondary students.

5) Interlinking Topics and Comprehensive Evaluation:

After all this, there is also the need for the child to be able to link together concepts in various

areas when having to deal with an application of its knowledge in real life. This includes being able to move between various modes of thinking about the world and representing this thinking. One manifestation of the lack of linkages is the difficulty children have in interpreting (sometimes even drawing) graphs. An example is discussed by L.H.T. West and P.J. Fensham[14]. Here a student who has read the normal boiling point and boiling point of bromine at a given pressure from its phase diagram is not able to say why a pressure cooker cooks faster till asked very leading questions. This paper goes on to suggest some ways in which inter-linkages in this topic could be aimed for.

One of the points that has been made by various people is that the way knowledge is broken down into subjects and topics within subjects followed by evaluation of these same 'discrete' bits of knowledge is responsible for the way children learn the facts of science in this piece-meal manner. This indicates that methods of evaluation too need to be considered while framing the curriculum.

Conclusion:

In conclusion, this report is an attempt to list the factors which would decide in choosing what to cover in classes IX-X Science and how to cover it. The following questions would have to be dealt with during the development of any topic / concept:

1. What are the ideas that children have and how would these ideas affect what we try to teach them?
2. How do we balance the need for enlightened citizens *vs.* the need for scientist – unless we convey some of the magic of the latest theories and findings and the questions they leave unanswered – how do we attract curious students?
3. How do we encourage critical thinking across fields?
4. How do we utilise the limited time available to convey both the interconnectedness of all scientific knowledge and also go into concepts deeply enough?

Finally, we also need to be clear about the kind of evaluation that our approach to a topic / concept requires and this should also be developed.

Appendix A:

The eight-fold way of constructivist pedagogy:
(i) learning should take place in real-life situations,
(ii) it should be understood within the framework of the learner's previous knowledge,
(iii) the content should be relevant to the learner,
(iv) students should be encouraged to take charge of their own learning,
(v) assessment should be formative and its result should inform further learning experience,
(vi) learning should involve mutual discussions among learners to resolve contradictions,
(vii) teachers should serve primarily as guides and not as instructors, and
(viii) they should encourage multiple approaches to learning.

Appendix B:

According to Allchin, using oxygen, Lavoisier could not adequately explain aspects of heat, light and combustibility. The later phlogistonists criticized these deficits in Lavoisier's scheme while emphasizing the corresponding strengths in the initial concept of phlogiston. They accepted the discovery of oxygen while maintaining the role of phlogiston in explaining the heat and light of burning. Allchin has used phlogiston at the introductory level to understand combustion and oxidation and reduction of metals without addressing its separate role in pneumatic chemistry. The students were to generate and draw on a set of observations which would also have been available in the 18^{th} century to find the relations between reduction of ores to metals, oxidation of metals, calcinations and reduction coupled together (one metal getting reduced while the other gets oxidized) and combustion.

Appendix C:

De Berg summarizes the difficulties surrounding the teaching and learning of the work concept as:

1. Some students find difficulty in associating equal work done with equal change in kinetic energy when presented with perceptually different objects which have been equally driven over a given

distance.

2. Work is often confused with force. Students often do not associate work with force and distance.
3. When students do define work correctly they are more likely to associate it with (force × distance) than change in kinetic energy.
4. Students find it easier to solve mathematical problems using the formulae for work, kinetic energy and potential energy than to give qualitative responses which depend upon the application of the formulae to real situations.
5. The common use do the terms, working day and working hours, counteracts the scientific definition of work which depends upon the distance application of a force rather than the time application of a force. The significance of the definition as (force × distance) needs to be addressed.
6. Textbook definitions of work use the applied force in some cases but the resisting force in other cases.
7. Linking the concept of work to the concept of energy by using definitions such as, "energy is the capacity to do work", is considered beneficial by some educators but detrimental by others.

According to De Berg, going into the historical development of these concepts from engineering concerns about defining efficiency and how theoretical reflection came later would help with some of the above difficulties.

Appendix D:

According to Lawson, the hypothesis given by Alvarez (T. rex and the Crater of Doom) for the extinction of the dinosaurs and how this hypothesis was arrived at 'exemplifies scientific discovery in terms of episodes of hypothetico-predictive reasoning' in which 'reasoning episodes were initiated by puzzling observations and causal questions, which were followed by the generation of alternative causal hypotheses via a process of analogical reasoning....Once generated, hypotheses were tested through the derivation of predicted results and by their comparison with observed results.' Lawson concludes as follows:

The present interpretation of scientific discovery also carries an important implication for science classrooms. If scientific discovery is indeed driven by hypothetico-predictive reasoning, then it follows that more instructional time should be spent having students conduct rich explorations in which they encounter puzzling observations in need of explanation. For example, consider the puzzling observation that water rises quickly in a glass inverted over a burning candle standing in a pan of water. After causal questions are raised (e.g., Why did the water rise?), students should be encouraged to use their prior knowledge of possibly related situations (i.e., using analogical reasoning) to brainstorm lists of alternative hypotheses (i.e., 1. The consumed-oxygen hypothesis: The oxygen is consumed creating a partial vacuum. So the water is sucked in to fill the partial vacuum. 2. The dissolving-carbon-dioxide hypothesis: As the candle burns, it converts oxygen to carbon dioxide. The carbon dioxide dissolves in the water more easily than oxygen, thus producing a partial vacuum. The water then rises into the partial vacuum. 3. The heated-air hypothesis: The candle's heat causes the air around it to expand and escape out the bottom of the cylinder. After the candle goes out, inside air cools, air pressure is reduced, so the water is pushed in by greater air-pressure outside. 4. The expanding-water hypothesis: The flame causes the water temperature to rise so the hotter water expands into the cylinder. 5. The clay hypothesis: The flame interacts with the clay, which holds the candle, in such a way as to release water into the cylinder.). Next, instructional time could be spend having students, singly or in cooperative groups, plan and conduct tests of their hypotheses – in order of the most plausible (to them) to least possible. Importantly, students should be encouraged to explicitly state predicted results prior to data collection and to test as many alternatives as possible with the ultimate goal of constructing convincing evidence-based hypothetico-predictive arguments concerning all of the alternatives.

PLENARY VI

NEW PEDAGOGY OF SCIENCE EDUCATION

021 AMARENDRA, NARAYAN (Dept of Physics, Patna University **Patna800005**). CONCEPT-ORIENTED SCIENCE TEACHING AND LEARNING

The poor understanding of Science among students by large is a matter of great concern for all of us. The need fostering good concept of the subject cannot be over- emphasized. The present paper is based on a cognitive approach and discusses the nature of cognition at different levels according to Robert Gagne's hierarchy and the need for appropriate study material that strengthens each of these levels. Several study tools and techniques are available today such as SQ3R study technique, Key-Concept mapping, Goal orientation, Time management techniques for improving memory, concentration and mental alertness. The paper discusses how they can be combined effectively for improvement of different aspects of teaching-learning leading to an overall improvement of concept among student.
Key words: **Science teaching, Concept formation, Study method (New pedocoly of science education)**

022 DIMPLE, SALUJA & PATEL, VARSHA (Department of Extension and Communication Faculty of Family and Community Science). SENSITIZING CHILDREN THROUGH EDUCATIONAL GAMES.

The project was carried out with the objective to develop instructional strategies and check impact of games developed to teach children on the topic environment education. The project was undertaken **at** karelibaug Bhagini Samaj Trust Sanchalit Shree Mukued Shukal Pustkalay and Vanchanalay of Baroda city. The children aged between 5-11 were selected. Instructional material like chart, poster, flashcard and methods like puppet show, drama, workshop, demonstration and exhibition and games like snake and ladder, loudo, housie and puzzle game were developed and their effectiveness was checked using questionnaire. The result showed that learning through game is learning without tension. All the children opined they like play way method i.e. Tambola most for imparting environmental education. They were having favorable opinion for motivational activities like dustbin making and diya decoration.

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023 GHODERAO, S.B. And KANKARIYA, R.D. (Dept. of Chemistry, RNC Arts, JDB Commerce& NSC Science College, **Nashik Road-422101**). DEVELOPMENT OF INTEREST IN CHEMISTRY THROUGH MIRACULOUS CHEMICAL DEMONSTRATIONS.

Many chemical educators are familiar with traditional demonstrations, with which different concepts in chemistry are made simpler.

With the miraculous chemical demonstrations, concept like exothermic reactions generally leading to combustion and the principal underlying of titrations involving color change are made easy and understandable.

The miraculous chemical demonstrations are used to develop interest in students about chemical sciences, explanation of so called miracles, develop scientific temper and eradication of blind faith too. These demonstrations can be done safely in a classroom or laboratory with prior training and knowledge.

There are many blind faiths, beliefs, or superstitions spread among people in the society. A large number of peoples believed in various types of miracles because of lack of scientific knowledge attitude,

and temper. The scientific principle underlying a particular 'miracle' may not be known at that time, but can be found out with scientific attitude. Most of the 'Godmen', Quacks and Conmen with similar motive of exploiting and harming mentally, physically and financially, the superstitious people in society perform a 'miracle'. Therefore, there is a need of explaining the scientific knowledge of so called miracles.

In present study 'miracles' and literature prepared about it, is used as an educational to develop interest in chemical sciences.

024 GEETHA, ARVIND and HARISH, AMUR (157/002, Sneha Residency, Green Glen Layout, **Bellandur, Bangalore – 560103).** ANUBHAVA SCIENCE LEARNING MODEL.

The current science education is largely classroom oriented, based on a theoretical approach. The focus is towards completing the syllabus, conducting examination and assessing the students based on these examinations. There are several questions that are pertinent in the field of science education today.

(1) *How do we shift the focus from a teaching to a learning process?*
(2) *How do we offer science learning experiences in the classroom?*
(3) *Does the abstract learning process demanding memorization and filled with information affect the child's interest, attention span, involvement to learn science?*
(4) *Does it extinguish the learning sprit?*
(5) *Is there a need for a system that focuses on science education that encourage the leaner to became inquisitive, creative and explorative thereby helping him to meet practical life needs and challenges?*

These thought and concern lead to the genesis of ***Anubhava Science Foundation*** **(ASF).**

The **Vision** of Anubhava Science Foundation is to significantly contribute to the transformation of facilitating every child to

- Learn science concepts
- Develop scientific thinking through experience and exploration
- Learn science in a joyous and stress free environment
- Bridge the gap between learning science in classroom & experience science in daily life

The **aims** of ASF are to

- Stimulate the child's mind to **EXPLORE**
- Enhance the **SCIENTIFIC TEMPER**
- **SENSITISE** the child towards scientific application
- Enhance the child's power of **EXPERSSION**
- Develop **LOVE for SCIENCE** in a joyful and stress free environment.

In order to achieve the vision and aims of ASF, Anubhava Science Learning Model (ASLM) has been designed. The ASLM model adopts a learner- centric methodology that assists a child to get exposed to fundamental principles following a concept-based design, experience, enquiry, and expression based implementation techniques and enable teacher to implement the same inside classroom.

Anubhava Science Foundation has designed programs to help teachers adopt ASLM and children experience this learning model. ASF has initiated multiple projects to implement these programs in Government and other schools.

025 KUMAR, RAM; KANT SHASHI (Regional Institute of Education Nantional Council of Education Research And Training Sachivalaya Marg, Bhubaneswar-751022Orissa). AN INNOVATIVE IDEA IN RE-INVENTING OF THE INDIAN SCHOOL CURRICULUM.

India has huge potential in human resources, agricultural resources, forest, rivers, seas a different mines climate conditions and existing social values. However we fail to tap all these potentials for transforming the country form developing to developed stage. The country needs proper education through which these potentials will be used by our younger generations. In this respect, we purpose a new innovative curriculum for our school education by introducing another subject such as "Quest" in secondary and higher secondary stages and through this subjects they will get opportunity to realize his or her own knowledge and may have the scope to invent/discover new ideas in collaboration with the educational institutions, farmer; research institutions and industries. It will help our country to solve some long term as well as short term problems, improve the quality of life of our and bring the leadership in the era of globalization.

026 KISHORE, KAUSHAL And PANDEY N. N. (Department of Education Guru Ghasidas University, **Bilaspur – 495009, Chhattisgarh,** Faculty of Education and Allied Sciences M.J.P. Rohilkhand University**, Bareilly – 243006,** Uttar Pradesh)**.** COOPERATIVE LEARNING: AN ESSENTIAL PEDAGOGICAL REQUISITE FOR TEACHING SCIENCE.

"Children's voices and experiences do not find expression in the classroom – often the only voice heard is that of the teacher. When children speak, they are usually only answering the teacher's questions or repeating the teacher's words. They rarely do things nor do they have opportunities to take initiative." These lines of Yashpal, mentioned in the draft of National Curriculum Framework, 2005 very clearly speak the truth of the classes of Indian schools. The lack of space for dialogue and students' creative expression in classroom turns an interesting subject like science into a nightmare. As a solution, Prof. Yashpal further suggests the structure of a class and says that in a class, interaction with teachers, with other peers of the same age group as well as those who are older and younger can open up many more rich learning possibilities. Cooperative learning approach is a right and suitable alternative to the traditional teaching approach which fits in to the needs of a classroom, as stated in NCF, 2005. It is an approach to instruction in which students work in small groups to help one another learn. They work together to achieve common successes and the members of the group swim and sink together. Various researches in different countries all over the world support that cooperative learning enhances achievement in many subjects along with significant positive contribution to development or enhancement of various psychological attributes like interpersonal relations among peers, social acceptability among peers, interest, motivation etc. There are various methods of cooperative learning which have been developed and researched in many parts of the world. They all have the idea in common that the students work in groups to attain a common goal.

Present study examined the effectiveness of STAD, a method of cooperative learning, in terms of achievement in science. The researchers also tried to know the students' reactions toward learning of science in a cooperative class. The sample consisted of forty students of grade IX. A 'two group pretest-posttest' design under quasi experimental design was used to conduct the experiment. Data analyzed using ANCOVA revealed the significant effectiveness of cooperative learning. Students accepted that learning science was more interesting and fun in a cooperative class.

027 MEHTA, RONAK And LELE, P.D And TRIVEDI, SANDIP (M.Phil student, Physics Department, Gujarat University, Ahmedabad.). INNOVATIVE TIMER FOR TIME And MOTION STUDIES DIGITAL TIMER USING SENSOR LDR/PHOTOTRANSISTOR. ADVANCED MICREOCONTROLLER BASED TIME MESUREMENT SYSTEM WITH PC INTERFACING FACILITY.

A stopwatch is generally an instrument used to measure the time elapsed from the time when it is activated to when it is deactivated. There are mechanical as well as digital versions of stopwatches available in market. The conventional stopwatches are switched ON & STOPPED manually. Therefore human errors and switching errors limit the accuracy to which Time can be measured. Here our idea is to generate an improved digital stopwatch with help of LDR/phototransistor based sensor. This hands free operation removes all possible human errors. It relies mainly on the pulses in the form of voltage which are used to start and stop the watch. This Digital timer (A) can be used in Laboratory experiments like Free falling Bodies, 'g' by simple pendulum, 'g' &'a' by inclined plane etc or any experiment based on time measurement between two Events. The TIME elapsed can be noted down from the Seven Segment Digital Display. In (B) we describe yet another Timer which has the facility to record multiple values of time measured and these are read off from a LCD display. Further additional facility has been provided to interface it with a PC where EXCEL file can be generated to store the readings and later utilize computer software to analyze the data as well as produce necessary graphs. This advanced timer is based on the microcontroller 89S52.

028 MEHTA, S.C. (Department of Post Graduate Studies and Research in Botany B.S. Govt. P.G. College Jaora M.P.). SIGNIFICANCE OF OTHER THAN LECTURE METHOD (OLM) FOR CLASS ROOM TEACHING.

Teaching of any student in the classroom is an art. Teacher- pupil continuum can be maintained by bringing diversity in the teaching pattern. There are many ways of activating the passiveness of the pupil. Following the lecture method of teaching the success of communication largely depends on the active participation of the recipient.

Continuous lecturing i.e. one-way flow of information brings monotony in the class. This is an impotent factor, which force the pupil to move mentally, out side the classroom.

Inquiry based interactive teaching is one of the important models which can be used in overcoming the problem of passiveness. There are many other ways of exposing the students to the understanding of scientific concepts and nature of science, concepts of social science etc. There should be a well-developed feed back mechanism so as to improve the teaching methodology.

029 MEHTA, RONAK And LELE, P.D And TRIVEDI, SANDIP (M.Phil student, Physics Department, Gujarat University, **Ahmedabad**). DO IT YOURSELF-VERSATILE TRIPPLE POWER SUPPLY FOR LABORATORY.

A versatile power supply is described here in detail. This low cost multipurpose power supply can be easily fabricated in the laboratory itself by teachers and B.Sc. final year students take as project. Single continuously variable 0-20V, 1A power supply is required for many experiments. Further fixed +5V, 1A power supply is used for all digital, microprocessor, microcontroller experiments. Finally, dual $\pm$12V, 1A power supply is required for OPAMP based analog circuit experiments. A single transformer is used here to build up a triple power supply which provides all above outputs simultaneously. The three terminal regulator IC LM317 is used for single variable voltage power supply while fixed +5V is

generated using IC 7805. The dual ±12V supply is based on ICs 7812 & 7912. The dual ±5V supply is based on ICs 7805 & 7905. Facility is provided using jumpers to select the required power supply. The actual size of PCB layout is also given here in detail. This very low cost supply can be PCB fabricated in about Rs 500/-

030 PATEL, ANKITA, SHOME, SAURAV AND NATARAJAN, CHITRA (Homi Bhabha Centre for Science Education, TIFR, V.N.Purav Road, Mankhurd, Mumbai 400088). RESOLVING CONFLICT OF IDEAS ABOUT PHOTOSYNTHESIS AMONG MIDDLE SCHOOL STUDENTS THROUGH MULTIPLE INTERACTION MODES.

Understanding photosynthesis is essential to understanding energy and material flow through the environment and especially through living organisms. This is rarely addressed either in textbooks or in classroom discussions. In fact, most classroom practices do not even acknowledge students' spontaneous ideas, and hence students retain their ideas as disjunct from the ideas they learn in the classroom. Photosynthesis and its role in energy flow through living organisms was hence an important area of study in an 8-day course on Energy and Environment that was conducted for students of Class 8, who volunteered from three similar English medium schools in the vicinity of our Centre.

The course design explored students' spontaneous ideas about photosynthesis and related concepts, including possible alternative conceptions, using multiple probes. Students' ideas were first probed through a question set. Students' responses were studied by the researchers and this was followed by a classroom discussion on photosynthesis. Students then carried out a few activities and observations on photosynthesis through a set of three simple experiments designed for the purpose. The students carried this out in groups. The results of the experiments, some of which failed, were discussed in the class.

Students' responses to the work sheet as well as during discussions reflected their misconceptions about photosynthesis and energy flow. The discussions gave an opportunity to address students' ideas and clarify them. Students were unable to make the link between photosynthesis and the flow of energy through living organisms. The paper will discuss students' ideas on photosynthesis, the importance of our sequence of classroom interactions, and implications of the findings in real classroom settings. The paper will also discuss the limitations of the sequence adopted in the course and the possibility for further improvement.

031 PAUL, WEBB (Nelson Mandela Metropolitan University **South Africa).** DEVELOPING SCIENTIFIC LITERACY:AN INTEGRATED TEACHING STRATEGIES APPROACH.

Research since the nineties called for scientifically literate citizens who can make well-informed decisions about scientific issues and who demonstrate curiosity about everyday experiences. It was noted by UNESCO at the closure of the 21st century that science education for the new millennium should provide the intellectual skills needed for addressing the challenges of the global community. While most past definitions of scientific literacy have focused on the notion of civic responsibility and decision making which impacts on personal and political well-being, Yore and Treagust (2006) feel that although science curricula which stress democratic, socioeconomic and personal well-being are appropriate, they currently do not sufficiently value and develop learner's cognitive tools and communication abilities. They argue that both communication and cognitive skills are necessary to be a scientifically literate individual. A scientific literacy strategy, based on Yore and Treagust's arguments which address the issue in both fundamental and derived senses, was developed jointly by South African and American science educators and trialled in South Africa. The strategy aims at enabling teachers to lead their pupils through a process which begins with a stimulus (reading, discrepant event, etc.), to classroom discussion and the formulation of an investigable question. Thereafter the learners design and implement the investigation, keep a 'science

notebook' (informal science writing technique), and engage in a scaffolded process designed to develop their argumentation and presentation skills. In brief, these skills are integrated into a series of events that aim at enabling learners to act as real-world scientists do – i.e., they read, discuss, formulate investigable questions and record their findings in an informal way. After this they are required to build up and present an arguable case based on claims, warrants, backings, data, and possible rebuttals which rest on both the data they have generated and supportive literature. The strategy also recognizes and addresses issues that teachers and pupils face in second-language environments and provides a basis on which teachers can assess and evaluate their pupils' levels of scientific literacy. Studies on the strategy which focused on grade 6 and 7 second-language pupils' were undertaken in rural and urban areas of the Eastern Cape where, despite the fact that the chosen language of instruction is English, most of the children have limited or no access to the language outside of the school grounds. Initial data generated by these studies suggest that use of the strategy over a six month period resulted enhanced scientific literacy, improved problem solving abilities and better reading, writing, speaking and listening skills, sometimes in both their home language and in English. The research also suggests that the process can be successfully adapted by teachers, but raises the caveat that the process takes time and requires ongoing support.

032 RATHORE, ABHISHEK, S. and FALGUNI SARANGI (Azim Premji foundation, 134, Doddakannelli, Next to WIPRO Corporate Office, Sarjapur Road, **Bangalore 560035,** Tel: +91-80-66144900/01/02 Board). RESPONSE ANALYSIS UNDERSTANDIND CHILDREN FROM THEIR FRAME OF REFERENCE.

Very often, we are so fascinated by the idea of 'right' and 'wrong' answers that we forget (or refuse) to explore the cause behind a child's response to an item. We are so engrossed in the "wrongness" of a response that we fail to appreciate the beauty of that response. This paper attempts to propose a more rational way of looking at children's responses than what we have been doing as part of 'assessing' our children's work. It is an attempt to build a perspective of knowing what a child has learnt rather than what (s)he hasn't learnt. In doing so, we also acknowledge the fact that we would never be able to definitely know how a child has understood a concept, as our inferences would be based on a few educated guesses, made on the basis of available evidence.

Response Analysis as a concept and as a process is nothing more than a perspective - a discerning eye to look for reasons behind a child's particular response to an item. One underlying belief in this work was our own recognition of the fact that all forms of assessments of children's responses carry some diagnostic information.

In the first part of this paper, the concept of Response Analysis is explained in detail, while in the second part, a few results obtained during a study - undertaken by Azim Premji Foundation to give qualitative feedback to teachers about the nature of errors that many children were often making in Mathematics and Language - are briefly presented. In 2006, we experimented with this idea of looking at children,,s errors and completed an error analysis study. In 2007, as our understanding developed with mutual sharing of experiences with teachers and academia, we began to capture much of the sampled data of children's responses not only based on errors but went a step beyond it. We tried to see patterns, saw connections with linked items, formed categories of responses, framed some inferences and tried to figure out the possible reasons thereof. Objectively, it also helped us to understand many probable responses that an item can elicit from children - which one might not have thought of during the development of the item.

Our understanding of Response Analysis is an outcome of this internal study performed on 1500 answer scripts of children. However, the potential scope of the study is much wider than just analyzing written responses as it can have far-reaching impact upon daily classroom teaching learning practices. This paper touches upon this aspect while it also discusses the conceptual understanding and process required for making such an attempt. Such a process should, we envision, inspire the teacher and definitely add value to an active classroom teaching-learning environment.

033 SINGH, RAKESH KUMAR And AMARENDRA NARAYAN (Deptt. Of Physics, Patna Women's College, Patna University Deptt. Of Physics, **Patna University).** CREATING INTEREST IN SCIENCE THROUGH LOW COST-NO COST DEMONSTRATION.

There has been a general deterioration in the level of understanding of science in India although many research institutions have been established nation-wide. This can be attributed to a lack of scientific culture. We present here a very effective method that creates interest in science, especially physics with help of Low-cost/no cost experiments. These experiment take five to ten minutes to perform and have great pedagogical value. We have demonstrated these experiments under various situations including regular classrooms. We have found that when combined with right type of questions, they are very effective tools for concept-building and interest generation.
Key Words: Low cost/No cost experiments, Scientific culture.

034 WADIKAR, SUNITA (Pillai's College of Education & Research, Chembur **Mumbai-400088):** SYNERGY BEWEEN – TEACHING STYLE OF SCIENCE TEACHERS AND STUDENTS LEARNING SYTLES

A Social study needs to be on the development of the four 'R's- Resilience, Resource- fullness, Reflection and Relationships which give the young students the keys to successful lifelong learning and to face the challenges successfully put forth by the changing educational scenario.

For this purpose, the educators in every field should enhance their teaching style which will compliment the learning styles of their students. Learning style is defined as the way the information is processed. Teaching style is expressed through the behaviors, characteristics and mannerisms that reflect teacher's teaching philosophy and the role they prefer to take when conveying information in a classroom.

Science is a subject which plays an important role in shaping the perceptions of the child. As a result, it is of paramount need for the science teachers to recognize which learning styles suits best to each pupil and adapt those teaching styles in order to boost the students' achievement in science. It is essential for the science teachers to understand that teaching style is not only about teaching; it is also about learning. It involves recognizing students as individuals, understanding their needs, and planning the learning process accordingly. Teaching style must include interacting with students and getting them involved in the teaching process. Thus, every teacher should perceive and should try to process the above information in various ways according to their perceptual and sensory strengths. This combination of perceiving and processing forms science teacher's unique teaching style.

Today's instructional methods of teaching science must be transformed to include teaching styles that will benefit the diverse group of students. But many science teachers prefer to use the same techniques, methodology or approaches to their teaching which they are comfortable with, like traditional way of teaching science through lecture method along with chalk and talk. These science teachers believe in delivering of knowledge and emphasizes on drill and memorisation, they adhere to the fixed science curriculum and teach from the prescribed science textbooks. However, trying different methods of teaching style by these science teachers may prevent the child from feeling frustrated and inadequate when the child is unable to work up to their potential, which may lead to underachievement of the students, anxiety, stress and frustration in the students as well as teachers. There are various theories given on teaching styles and learning styles.

Anthony Grasha identified five potential approaches for classroom teachers: Expert, Formal Authority, Personal Model, Facilitator, and Delegator.

The three most common learning styles are:

PLANERY-VIII

EVOLVING NEW DEMOCRATIC SYSTEM OF EDUCATION TEFLECTING PEOPLE DEMOCRATIC NEEDS, ASPIRATIONS AND CREATIVES URGES.

035 ABROL, DINESH (SCIENCE TECHNOLOGY DEVLOPMENT STUDIES, DR. K.S KRISHANAN MARG, **NEW DELHI**). NEED TO ENCOURAGE INTEGRATED SCHOLARSHIP THROUGH OPEN SOURCE INNOVATION (OS), OPEN EDUCATION RESOURCES (OER) & OPEN ACCESS (OA) TO RESERCH.

036 DAS, MANAS (37, Chattam Lines **Allahabad 211002).** EDUCATION OF THE INDIVIDUAL.

Science is associated with rationality, with the understanding of processes, and with the possible application of that understanding. There are areas of human life that science has not so far touched; which, nevertheless, are of utmost human and more than human significance. The human race and planet earth are threatened by violence today. With scientific rationality there is need to think of an education of the human brain that can bring about an end to violence. In the natural world there is neither violence nor peace. It is the human brain that perceives and creates values. Therefore, the coming to be of that brain which is the ground of healthy values and, therefore, of a harmonious universe, should perhaps be the first concern of education. This paper deals with the education of the brain that knows, and not with the information, the know hows, the ideologies, isms, and programmes that are stuffed into the brain under the name of education. Perhaps it is high time we looked upon education as the making of a human being, and not as the production of human resource up for sale in the global market.

037 DAS, MANJULIKA (37, Chattam Lines **Allahabad 211002).** INDIVIDUAL BE NUTURED: REPORT OF AN EXPERIMENTAL EXPLORATION.

What can bring about a responsible, sensitive and compassionate society? J.Krishnamurti's "you are the world" tells us forcefully that each individual is responsible for the world she lives in—she can make or break it. The individual is the smallest but the most powerful unit of the social fabric and if a change can happen here then what may follow is a harmonious society. Can such a sensitive brain be nurtured? Only a sensitive brain can be the ground of evolution. A brain that is free, a scientific brain that is able to see fact as fact unhindered by personality.

This was our quest. Can theory and praxis be brought together? My paper is a report of an exploration in education(as agent of change) beginning with the uncluttered minds of children in a village school and going on to work with youth, particularly women who can act as agents of change in families and schools.

038 GHARE, DHANANJAY B. (Indian Institute of Science, **Banglore):** REMODELED LOOK OF INDIAN EDUCATION SYSTEM DURING THE 21ST CENTURY AD

We very proudly learn in History that **"For Thousands of Years"** (before the British Raj), India Played the Role of the **"guru"** (of then- then latest and best form of Education) on the Global Scenario. In those days, the **'Temple'** were playing the Role of School Buildings for

(a) Seriously Registered (Accepted by Guru's) Students in the Morning and
(b) For adults in the evening when education was imparted mainly through "Entertaining Programs" involving Dance Drama bhajana's keertana's' pravachana's etc.

"Teertha_Xetra" Temple were like **Universities** and special gurukula's or aashrama's of Sages were also like Universities- Research Laboratories etc.

The Structure of the Traditional Indian Education System, was heavily weakened, during the Several Centuries Period (1100 to 1800 AD) of Muslim Invasions, Rules and Prolonged Political Instability Swami Vidy Ara Nya teertha and samartha ramadasa tried to stop the erosion to some extent.

With the British Raj, the entire "Traditional_ Indian_ Education _System" was totally away and officially discouraged & demolished.

However, during the British Raj, Lokamanya Tilak and his friends under the leadership of Chiplunkar started New Educational Institutes with **Western Styled Syllabus & Indian Flavor of Teaching**. Madan Mohan Malviya started similar Institution in Banaras and Tata's House Founded " Indian Institute of Science" at Bangalore.

After Independence in 1947 AD, Pandit Jawaharlal Nehru got **Fiver IIT's established in New Delhi, Kanpur Mumbai, Madras (Now Chennai) and Kharagpore (near Kolkatta)** and a tradition of World Class of Highest Level of Technological Education Institutions (though on Western Style) got established again.

A vast majority of the students who graduated from these Institutions were absorbed by high salaried Jobs in Technological Advanced Countries Like USA, Canada, UK (and also in Japan, Singapore, Australia France & Germany etc. to a smaller extent.)

In the **1950's to 1970's** Indian universities and Education Institutions were attracting Students from east Asian, West Asian and African countries and **there was a Flavour of India Playing a Leading Role in International Education Senario, at least for the Nonaligned Developing and Under developed Countries.**

As these Countries established their own Educational Institutions, this process got drained off and today Indian Universities are hardly attracting Students from Foreign Countries (in any major or significant number).

With Desktop _ PCs, Laptops, Notebook_ PCs, Internet and TV Channels, the Role of Teachers in the School Building is bound to change and the World is moving towards Household Drawing Rooms and Bed rooms as the Basic Schooling premises for the primary and High School level Education.

With in a few forthcoming Decades, School Building will be required mainly for

(a) Laboratory Experimentations- Demonstrations &
(b) Conducting Sports, Gatherings, Examinations etc.

Hard Copies of Printed forms of Books will slowly disappear and **CDROMs and Pen Drives** will contain **"Whole Libraries of Books" in the Pockets of the Students** .

How the Indian Society and Culture will & Should react to these " Revolutionary Changes" bound to happen in the Global Education Scenario and

Some ideas on **"Re_ gaining"** the **Foremost Leadership Position of 'guru' on Global Scenario by (a Indian as a Nation and b) the Indians as a community** (where ever they are located: in the **"vidvaan Sarvatra _ Poojyate", "Vasudhaiva_ Ku Tumbakam"** Spirit) in the Focal Theme of the Paper.

039 RAY, PRASANTHA (Presendcy college, B.K 365, Salt Lake **Kolkata700091**).

TAKING THE SOCIAL SCIENCES TO THE PEOPLE DISMAY AND HOPE

It is always a worthy thought the sciences be taken to the people so that they can learn them and use the knowledge variously. It may be to acquire skills any education imparts in the learner. At a more fundamental level, it may be that the knowledge of the sciences gives them a new life-view and a world-view. They may even use these to change their social location and emancipate themselves from both social structural fetters and from false consciousness about the origins of their problematic existence. The socialization of the sciences, which is the cherished outcome of taking the sciences to the people, will obviously have a re-constitutive impact on society, culture and life chances for the people benefiting the dispossessed at any point of time. It will give substance to democracy by breaking down elitist monopoly over knowledge and its dissemination. It can also create a civil society distinguished by right to voice and right to exit. While we celebrate taking the sciences to the people as one of great civilizational significance, we need to ponder over the problems such a project is likely face. The focus is on India for obvious reasons. But this is a universal issue.

The central proposition here is that it is difficult to take the social sciences to the people. This is not arguing that this is not true about the natural sciences. It is correctly observed that "A majority of scientific ideas from Galileo to Mendel, were friendly to the human capacities for imagery and, therefore, easier to understand and explain to a curious public."[1] Even then, new advances in the natural sciences are now reported in the newspaper or the electronic media on a scale far larger than it used to be. This is true about India or countries like India also. There is popular science movement in India particularly by various rationalist organisations. [Kerala *Sastra Sahitya Parishad* / Kerala Science Literature Society, 1962] [2] However, it is true that such enterprise is confined, both as the agent and the learner, to the middle and upper classes in the metropolis. This is primarily because the metropolis is culturally pluralistic and ready to give space to interrogations and critiques. Another reason is that teaching of all the sciences, natural and social, is mediated through the formal education system; and metropolitan centers are well ahead of their vast and variegated hinterland in terms offering education to those who can buy.

Coming back to the question of taking the social sciences to the people, we need to locate the complexities of the difficulty, and probe into rather than take for granted, in a surge of optimism that we only have to begin the venture, that the complexities will 'melt into thin air'. To create out of an untested conviction can be a folly.

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[1] Kagan, Jerome: The Three Cultures: Natural Sciences, Social Sciences and the Humanities in the 21st Century: Revisiting C. P. Snow, Cambridge University Press, Cambridge, 2009, p. viii.

[2] Science journals, organisations and movements in India: *Vigyan* (Science) — a monthly popular science magazine in Hindi — has been published by Vigyan Parishad (a learned society of scientists and academics) since 1915; — previously the Publications and Information Directorate the popular science journal *Vigyan Pragati* (Progress in Science) in Hindi, The Science Reporter in English, *Science Ki Dunia* in Urdu, 11 professional scientific journals and popular science books published by The National Institute of Science Communication (NISCOM); both governmental enterprise like Vigyan Prasar, an autonomous organisation of the Department of Science and Technology [1989], and non-governmental initiative like by the Indian Science Writers' Association (ISWA), [1985].

What we need to remember that the social scientists, particularly sociologists, in India, as elsewhere, have believed that the social sciences provide superior knowledge of society; and that they can contribute to social progress. Enamored with the western social sciences in both their liberal and radical versions, the 'southern' social scientists immersed in the European tradition, have found in them the outsiders' detached perception of their societies in the capitalist periphery; and hence a reliable understanding. Further, the social sciences have since their inception created an impression that they can contribute to social reconstruction. But the academic social scientists have never ventured into disseminating the social science perception of society to the people in intelligible language. There has been no persistent movement to expose the people to the knowledge of the deep structures of oppression and camouflaged mechanisms of creating and sustaining false consciousness; nothing beyond the night classes for the working class and middle class party cadres run by the communist parties. True, the public intellectuals and the scholar-teacher-activists speak beyond their class rooms and seminar halls. But they too take the social sciences to the people as a part of a larger project of political mobilisation. They do not persistently experiment with ways to communicate with the people beyond their likes and beyond their political frames.

Before proceeding to substantiate the proposition about the difficulties of taking the social sciences to the people, it is necessary to work out such conceptual clarifications. In the process we also begin to apprehend some of the problems. Towards that, it is best to raise some questions without ever insisting that these will exhaust spaces for interrogation. The answers suggest the kind of meanings attached to the basic terms on which the thesis of taking the social sciences to the people is built upon.

Who need the social sciences?

We can think of three kinds of people. [1] The vulnerable people, particularly those who suffer from interlocking vulnerabilities due to their location on any of the ascriptive axes of caste, tribe, ethnicity and gender; or/and due to their class locations and locations in power structure: The vulnerabilities are either existing or emergent. The basic premise is that they can not comprehend the sources of their sufferance and they will gain from exposure to the social sciences; they may even use the new insights to deal with the sources and the mechanisms of their sufferance. For example, the people who have been trained into believing that their every day misfortunes are due to their *karma*, may learn through an exposure to secular social sciences that their misery is due to their lowly location in the social hierarchy and that there are agencies and mechanisms of sustaining their misery. [2] Those who are not social marginals, say, people in the middle class-upper class spectrum: Take the example of middle class youth entrapped in individualist orientation who can figure out how capitalist modernity institutionalises instrumental rationality by exposure to sociology of capitalism; or the middle class women who can decipher patriarchal codes in every day practices by knowing the feminist standpoint. [3] The people skilled in the other sciences: like those engaged in creation of artificial life need to know the sources of moral resistance to such experiments.

But obviously the last two categories of people have the social position, the financial wherewithal and a cultural preference for formal education which enable them access knowledge in a market economy rather than wait for some body to take it to them. So, for the purpose of this presentation the focus is on the vulnerable people. Though this focus is easily defined, it is necessary to ponder whether they would have the spare time to listen to social science exposition pedagogically re-worked to be easily comprehensible for them; also, how much of the lesson would be sufficient for their conviction.

Where do we get them in order to impart them with the social sciences?

Assuming for the moment that they gain by the social science analysis of their marginality and assuming that there are other-wise disinterested individuals, the question crops up where to get them: reach them or receive them, whether we seek the people or meet them when they seek us in search of a deeper understanding of their social situation baffled by their experiences and encounters?

In the first case, we may locate them guided by our knowledge of the social map which point to concentrations of social marginals. But we need also to reach them but only after negotiating with the gate-keepers or their almost insurmountable inertia. In the second case, when they seek understanding on their own and look for the knowledgeable, we need to have a certain visibility so that they can locate us. In both the cases the knowledgeable must have the wit to answer their queries in their own terms. This requires

translation of the esoteric knowledge of the academia into common human understanding. What is probable is a clash between contextual time-space specific folk knowledge of society and projections of universal knowledge of society. This ontological clash can combine with an epistemological mismatch between the methods of knowing a people have been following over a long period of time and the new epistemology put forward to them.

The question 'where do we get them' has another dimension; in a sense more real and immediate: to get them at their homes, in their workplace, in the local tea stall where the unemployed and the unemployable while away their time, in prisons?

Who are 'we'?

'We' refers to individuals or groups who believe that they command the appropriate knowledge and power to enlighten those who are, knowingly or unknowingly, in the need for understanding they can not reach by themselves. Our claims to 'superiority' rest on our formal training in the academia, our networks with centers of power and counter-power, our organisational resources and a sense of emancipatory mission; on a deeper thought, on our social privileges which have facilitated the attributes just mentioned.

Given the visible social difference between the formally educated, probably urban and middle class individuals with a mission to help the vulnerable people – the donors, and the people – the recipients, can we take for granted that their relationship would be unproblematic? Would the donors be trusted by the recipients?

What do we mean by 'taking the social sciences to the people'?

'Taking the social sciences to the people' obviously means imparting in them relevant elements of social science understanding of their existential conditions, but not towards mere curricular fulfillment. The intention is to help them understand the conditions of their every day existence as well as the history of their social location. It would also mean that the disciplines would be carefully translated in every day language with illustrations drawn from their lived experience. This is no easy task. It presupposes the existence of organic intellectuals [Antonio Gramsci, 1891-1937] in the ranks of the masses: not the intellectuals who consider themselves exceptional, but thinkers who are 'born' within a class. They do what the masses can not: express their own experience and feelings in their own language. Here too there are critical questions: should they remain autonomous of political formations which want to lead the vulnerable people in emancipatory movements, because in case they do join or are incorporated in such political formations, they are likely to create and sustain another regime of meanings? What if such formations engender new vulnerabilities for the masses?

What kind of social science we want to take to the people?

Normally, the kind of social science we think we have mastered and the people need to know in order to locate the foundation of their misery, is what we want to impart in them. It is possible that we ourselves have been transformed in our thought process through such social science which has sensitized us about its emancipatory potential. It is natural that such social science is aligned to an 'ism', like humanism, liberalism, Marxism and Gandhianism, because it involves visions about a just world. But history throws up disturbing questions: Can the vision compromise objective understanding that the social sciences, at least those of the positivist mould, promises? Can the inspiration sour into a cynical distrust of emancipatory projects? Are the social sciences sufficient by themselves to lead to demystification of the social world?

Why do we want to 'take the social sciences to the people?

The hope is that they will gain an insight into the dark side of their existence: their subjugation and de-humanisation by the powerful. Some of them can even become aware of being unwitting beneficiaries of inequalities when they themselves are locked in the same nexus of power and subjugation as their fellow men and women are; 'the sub-oppressors' as Paulo Freire would call them. Broadly, it is believed that the knowledge of the social sciences can help them interrogate the social order in a comprehensive sense and critique the knowledge about it received from other agencies like the religious organisation or the political elite. 'The comprehensive sense' refers to an ability to relate the local

experience on the part of the people to the broader configurations in power, economy and culture. 'Critiquing the received knowledge' means a cultivated predisposition to scrutinize the knowledge handed over to the people by the powerful. What is problematic in this line of thinking is the excessive trust reposed on the social sciences.

How do we take the social sciences to the people?

Normally, engaging them in interactive discussions with a focus on an issue from their everyday experience will be an appropriate procedure. That presupposes that the initiators need to locate the relevant social science cues which the people will easily locate as an intelligible way of re-reading their life experiences. The language, the illustrations and the reasoning have to be carefully crafted in course of a dialogue between the initiators, who are without a sense of superiority, and the people who do not suffer from a sense of diffidence.

There are problems here also. Some people can argue that social scientists' intervention with a design to teach the people the social sciences / portions thereof resembles the logic of 'white man's burden'; that It is not improbable that the learned men can in the name of / with an intention of emancipating them end up indoctrinating them.

[2]

Those who are critically inclined, they locate the overlapping issues if inequality, injustice and under-development as central to the lives of the vulnerable people. If we take Sociology as representative of the social sciences, we can rightly point out that the rich sociological tradition has some place for the issues. The Marxist and the neo-Marxist, radical feminist and subaltern studies – all address to vulnerabilities in hierarchic societies. But the mainstream Sociology is dominated by the issue of social order, even a defense of inequality as in the functionalist frame of reasoning. This marginalises the critical and radical change seeking strands. Theoretical abstractions, analytical concepts and sophisticated methods of research, all in English language, place the insights into the working of an unequal social order beyond the reach of the vulnerable people. The division into highly professionalized social sciences, rather than one unified social science, and education in the social sciences being monopolized by fee-charging universities and colleges also stand in the way of easy access of the people of the weaker sections. Among the many reasons for the rise of the social sciences, the need of the modern state for increasingly exact knowledge of society is significant one. This state like the state at any point of time serves the predominant social interests. The welfare state and the socialist states are no exceptions. The contemporary harnessing of the social sciences for improving the competence of workers of every kind, from the industrial worker to the knowledge worker, signifies a new priority for the social sciences in the post-Fordist, neo-liberal capitalist order, namely how to subserve the interests of the finance capital. Does the middle class mobility-seeking average social scientist have the time for reaching out to the vulnerable people? Further, the carefully crafted disengagement between the humanities and the social sciences has mopped up the emotional urgency to use the social science knowledge for conscientisation. The over-insistence with the principle of value-free enquiry in the hope of attaining objectivity in research by the practitioners of positivist social sciences has made them blind to the moral concerns of the people.

There have been reflections on restructuring education by a wide range of philosophers of education like Tagore and Gandhi, and by social scientists including experts on education. The essays on education by Krishna Kumar in his *What is Worth Teaching* [2004] [3]are a brief collation of view points. But the essays do not address the question of taking the social sciences to the vulnerable people so that they can understand their plight; nor does the call for restructuring the social sciences based on reflections on the western experience. The Report of the Gulbenkian Commission on the Restructuring of the Social Sciences titled *Open the Social Sciences* prepared by Immanuel Wallerstein [1997] is one good example. The 'Open' here is a call to 'amplify the organization of intellectual activity without attention to current disciplinary boundaries'[4]. It is not a demand to open the social sciences to the vulnerable people. The literature on the

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[3] Kumar, Krishna: *What is Worth Teaching*, Orient Longman, New Delhi, 2004.

[4] Wallerstein, Immanuel: *Open the Social Sciences: The Report of the Gulbenkian Commission on the Restructuring of the Social Sciences*, Vistaar Publications, New Delhi, 1997, p.94.

urgency of indegenising the social sciences is not based on an argument that these will make the social sciences easily intelligible by the laity.[5]

Even when a comprehensible education in the social sciences, call it appropriate or alternative, could be devised with the right pedagogy, and the vulnerable people are willing / easily persuaded to learn a new insight into an old existential issue of how to cope with a predatory social system, it would not be a cake-walk for any body, the educators and the learners. Because vested interests are unlikely to allow both to be a source of challenge to their power and privileges. Further, the social sciences have strong and enduring associations with political ideologies. Hence opposition to any of the perspectives originates within the folds of the social sciences themselves.

[3]

It is common knowledge that prospect of an objective understanding of the causes and consequences of their social marginalization by itself is not an attractive invitation for the vulnerable people. The possibility of organised intervention in their conditions of existence towards amelioration can boost their eagerness for new insights from the social sciences. The intervention can come in the form of state initiative or from civil society initiative. While there is evidence to argue that state has not always been blind to the needs of the vulnerable people, its interventions have not been adequate to the task. And what is more anomalous in the context of democracy and republicanism, the state by its action has engendered new vulnerabilities and invigorated older vulnerabilities. The civil society initiative or the so-called NGO activities do not address to the fundamental asymmetries of an unequal order. This leaves a third option: intervention in the form of collective action under the leadership of a political formation.

But 'taking the social sciences to the people' will be a sustainable engagement only if it is not a counter-hegemonic design as a part of a political project. A spirit of rebellion rather than a slogan of revolution should be intrinsic in the unceasing endeavour. This is because a revolution itself can create new vulnerabilities and new victims. The necessity of subverting a post-revolutionary regime of knowledge, an apparently a new tool of thought control, is a real one. This must also mean continuous re-constitution of the social sciences, at least of their priorities, as well as the self of the social scientist under conditions of democracy. The focus should be the same. Borrowing from Paulo Freire's dedication in his small but powerful book *Pedagogy of the Oppressed* [1972], we may define it as an attention to the '... the oppressed, and ... those who suffer with them and fight at their side'. For Freire, the agenda of learning by the vulnerable people must be set *with* them and not *for* them by the knowledgeable persons. The agenda is to be formulated only through dialogue between the 'intellectual' and the differently knowing 'ordinary' persons, with all the humility on the part of the former. The task is to initiate and sustain 'conscientisation', that is, learning to locate all forms and sites of social contradiction. A humanist, who is undeterred by a possible charge of utopianism, Freire is convinced about ordinary man's intellectual power despite being subjected to the 'culture of silence'. That should be the spirit for any initiative to bring the common people within the epistemological community of the social sciences.

A Postscript

Since 'vulnerability' has been taken here as one distinctive attribute of 'the people', it can be argued that vulnerabilities are not due to poverty, illiteracy or negligible education or lowly location in society's social and economic hierarchies only. By this logic, natural scientists have also been evidently vulnerable: vulnerable in the face of institutional control or the policies of the ruling regime in the state. The persecution of natural scientists is well-recorded in history. We can take the case of Einstein. Some among his fellow physicists condemned the fanfare surrounding the dubious theory of relativity; some called it "a Jewish fraud." Even his life was threatened, home ransacked and property burnt. The exodus of Jewish scientists to escape the holocaust would mean that suddenly natural scientists are brought down to

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[5] Oommen, T.K, *Alien Concepts and South Asian Reality: Responses and Reformulations*, Sage, New Delhi, 1995; Madan, T.N, 'For a Sociology of India', *Contributions to Indian Sociology*, 1966, No.9, p.9-16; Marriot, McKim: 'Constructing an Indian Ethnosociology', *Contributions to Indian Sociology*, 1989, No.23 (1), p.1-39; Alatas, Syed Farid: *Alternative Discourses in Asian Social Science: Response to Eurocentrism*, SAGE Publications, New Delhi, Thousand Oaks, London, 2006.

the level of ordinary refugees; though, may be, unlike the ordinary refugees they carry with them substantial social and cultural capital. The social scientists suspected of anti-Marxist leanings or of being critics of the ruling communist parties had to leave Soviet Union and China in the heydays of Stalinism and Maoism.

But short of such a contingency of political persecution of scientists, the scientists are likely to gain through social science insights. This is particularly true of a vast number of scientists who are so immersed in their scientific research that they have no time, may be no aptitude either, to ponder over the social implications of their research. Let us take one contemporary instance.

The revolution in molecular biology and molecular genetics is one very significant development in recent times; so is the micro electronic revolution. The molecular revolution is very likely to shape how we perceive and relate with each other in a multiethnic society. Much of this research is understandably conducted in universities and institutions in the western countries with huge funds and organisational control of coordination much beyond the comprehension of collaborating scientists from the 'south'. There is a breed of 'innocent' apolitical scientists, unlike Einstein. Einstein wrote in a brief essay *Why Socialism?* in1949: "I am convinced there is one way to eliminate these grave evils (of capitalism), namely through the establishment of a socialist economy, accompanied by an educational system which would be oriented towards social goals."[6] But this was not sufficient for an authoritarian regime. For the Soviet communist party during the Stalin era (1929-1953), Einstein's 'crime' was formulation of 'idealistic' principles in his theory of relativity. Some of his Soviet compatriots in the physicists' circle, perished under Stalinist purification.[7] That was not the end of his suffering. For the same theoretical contribution, the Gestapo in 1933 searched his home and confiscated his property lest it would finance a communist revolt, forcing him to take refuge in a Belgian sea resort in 1933.[8] In May, Goebbels, Hitler's propaganda minister, organized a public book burning, prominently featuring Einstein's work. In 1954, in response to the denial of security clearance to his colleague, J. Robert Oppenheimer, and of the freedom of scientific inquiry, Einstein wrote, that if he were young again, "I would not try to be a scientist or scholar or teacher, I would rather choose to be a plumber or a peddler, in the hope of finding that modest degree of independence still available under present circumstances."[9] He was alert and sensitive about the need for freedom; most scientists are not.

Coming back to the contemporary scientific revolution, it is useful to refer to The Human Genome Project, which is an endeavour to map and sequence all human genes. An integral part of it is the search for SNiPS [single nucleotide polymorphisms]. As a marker of chromosomes in construction of genetic maps to identify, say, genes involved in diseases, it commands an enormous appeal even for ordinary people capable of understanding of science communication in the media. But what many scientists engaged in such path-breaking scientific research may not know that it has the potentiality of perverse use for discrimination against some politically targeted groups by the state, the ruling party and the hegemonic social groups which seek to protect their power and privileges. They may not figure out that in imperial democracies like the US, such research is driven by political prejudices like race. This is "the re-emergence of "race" in molecular biological clothing."[10]

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[6] Green, Jim (ed): *Albert Einstein: Selected Writings*, LeftWord, New Delhi, 2004, p 80.

[7] Vucinich, Alexander: *Einstein and Soviet Ideology*, Stanford University Press, 2005.

[8] Bernstein, Jeremy: *Einstein*, Fontana Press, London, 1973, p 10.

[9] Simon, John J: *Albert Einstein, Radical: A Political Profile*, Monthly Review, Volume 57, Number 1 May 2005.

[10] Duster, Troy: 'The Sociology of Science and the Revolution in Molecular Biology' in Blau, Judith R. (ed) *The Blackwell Companion to Sociology*, Blackwell Publishing, Oxford, 2001.

It is beginning to gain public attention that "technology is far too important to leave only to engineers; social scientists, historians, and citizens should also have their say."[11]

040 YADAV, PRAMOD (School of Life Sciences, Jawaharlal Nehru University, **New Delhi 110067).** HOLISTIC EDUCATION SOME PROPOSITION.

Intense exercise of education prevalent over the past few centuries has resulted in a stereotype leaving little room for cultivation of the innate potentials of students. The grades get overemphasized without there being an absolute reference. What I am going to say is a compilation and recapitulation of experiences of scholars in past. Let us assume that there is no debate that there should be an opportunity for all as a matter of right. Trends in commercialization of education need be reviewed and rationalized. I have been an advocate of free education for all but for the sake of corporate rationalization, I would remain open to 1% of total income of parents going towards education if the quality of institutions is assured to be uniform. Those limited by means will have to be exempt even from this expenditure.

While it is important to get literate and be able to read and write, it should only mark the beginning of education. Each perceptive mind cannot but be creative. The least it creates is a pictorial analogue of all it perceives which if allowed to come out is likely to lead to novel patterns of information translation. Hence any attempt to educate must necessarily involve as many media of communication as possible and must illustrate the diverse manifestation of human realization through all its senses viz. visual, olfactory, taste, auditory, touch and the abstract. There should not be segregation among disciplines in the name of specialization at an early stage of education. Students must be exposed to Nature and shown how natural undulations, mosaics, sounds, rough surfaces and fragrance make a beautiful appeal. This should initiate in the students a quest for beauty finding manifestations in drawing, paintings, music, sculpture, and other art forms. They should have opportunity to connect to them at one stage or the other during their primary and secondary education. They should also be engaged in gazing the celestial bodies and periodicity of their movement. In the meanwhile and exposure to properties of numbers should give them a sense of quantitative relations. Skills like carpentry, spinning, weaving, pottery, oil extraction, culinary art and food processing and preservation, smithy, and sanitation should be introduced in a game format. It will be a good idea to assign 3 to 4 weeks of annual civil works till a certain age along the lines provided in Switzerland. Formal sciences like Physics, Astronomy, Chemistry, Earth Science and Life Sciences should be brought in only small doses to lay the foundations. In an over-enthusiasm of making our students learned, we tend to make a heavy downpour of information which should better be postponed till the foundation is laid. There should as well be space to state the essential parity among all, commonality of ancestors of all living beings and common origins of all that exists. It is a lot of material to be delivered within the initial eight years or so. An introduction to common civic responsibility and basic ethics, must also be delivered. We cannot leave students for management programs that amidst other things teach killer instinct and cut-throat competition. The gradual specialization in various disciplines must not create water tight compartments between sciences and humanities since no discipline can be considered non-scientific. May education be enlightening and produce independent thinking minds.

(An abstract of presentation for Second Peoples' Education Congress)

Introduction:

Necessary and avoidable facets of education: It is important to articulate, manifest and communicate. Letters are the most convenient medium for doing this and hence it may be considered necessary to be literate unless alternative media for communication are brought into place. We must remain open to accepting such alternatives after due evaluation of their effectiveness. Who knows this might lead us to a paperless and more environment-friendly method in place of the present paper-based learning. As to what to learn, we shall have to bring in greater degrees of freedom than provided at present. Can we replace

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[11] Hughes, Thomas Park: 'Shaped Technology: An Afterword', Science in Context, No.8, 1995, quoted in Allen, Michael Thad and Hecht, Gabrielle (ed): *Technologies of Power: Essays in honor of Thomas Parke Hughes and Agatha ChipleyHughes*, The MIT Press, Cambridge, Massachusetts, London, England, 2001, p.20.

present stereotype defined syllabi with major objectives of education that would ensure making of good human beings with manifest creativity, compassion and conscience from each student. We shall have to take care not to replace one stereotype with another. Each student should have the freedom to imbibe information through existing documents and reconstruct his view of the matter. In a way, given the pool of existing information, each student since day one tries to create new knowledge. Information, learning and creativity can alternate with each other at a higher frequency than required in the present curriculum for education. The output can be a script, a principle, a poem, a piece of clay model, a painting, a sound track, a postural expression or any other form that the student finds fit. However, we must also continue with the present system of learning as well lest we loose so much of information/knowledge created by human effort and documented in literature. It is extremely discomforting to propose a resignation from all the existing material- and often energy-intensive technology. The drive for alternative technology may just suffice. In this context, the existing system of learning can still trigger a new string of thought processes in independent spheres. The idea is not to restrict learning due to present stereotype of education as once said by Einstein "The only thing that interferes with my learning is my education."

It has to be kept in mind that we return to the society all that we get from it and this includes learning. We must provide for employment for all willing and produce eligible employable individuals to meet all social needs. The compulsion to make a certain grade point in the examinations through once in a lifetime opportunity must go. Opportunity must be provided on demand to test oneself in a manner one wants. It has become feasible with the assistance of IT tools. So what is the level of education one is talking about? This can in spirits be applied on a continuous basis all through an individual's life and graduation, if continued, should not halt with a doctorate. Sky be the limit for higher education. One also encounters the recognition system for accomplishments often non-objectively evaluated by committees of a few. Can we not do away with them?

Limitations of the present system of education and its evaluation:

It is important to clarify limitations of the present system of education before bringing in an alternative one. As observed by Albert Einstein, the present system of examination involves inevitable passage through efforts being made to find what a student does not know rather than meaningfully amplifying what she/he knows ("Most teachers waste their time by asking questions which are intended to discover what a pupil does not know, whereas the true art of questioning has for its purpose to discover what the pupil knows or is capable of knowing."). Einstein duly highlights the beauty of the mysterious and goes on to state that "imagination is more important than knowledge". He also remembered schools as prisons where the child gets isolated from nature and has no option but to face a black board. "This crippling of individuals I consider the worst evil of capitalism. Our whole educational system suffers from this evil. An exaggerated competitive attitude is inculcated into the student, who is trained to worship acquisitive success as a preparation for his future career" says this scientist, and goes on to say "I am convinced there is only one way to eliminate these grave evils, namely through the establishment of a socialist economy, accompanied by an educational system which would be oriented toward social goals."

This proposition gets very close to our contemporary debate on right to education as a fundamental right, an issue viewed and debated differently by different people. The later sections in paper try to focus on kind of education.

Gandhi's dreams of education being freed from all personal obligations has barely been realized and education continues to be intensely competed activity to secure the best living. It is remarkable that he could foresee a threat to his concept of Swaraj if education continued to be a means of making the two ends meet. "Parents only know that it will help the boy to earn money. And this satisfies them. If this situation lasts long, we might all become foreigners! What is worse even the Swaraj for which we are struggling may become foreign in character when we finally get it, with the result that the very burden under which we are crushed today may continue even after Swaraj." Apparently he did not worry about the girls' education.

The purpose of creative activity of all kinds is praxis without imposition. This ought to produce independent minds needed for true leadership and as an author said "Leadership praxis in higher education is dialogic strategy, action, and balanced measurement that recognizes, embraces, and takes responsibility for the obligation of higher education to shape society and change the world" (Rob Abel, A-HEC).

The socio-economical considerations of education:

The state must commit adequate resources for educating the people. Education be treated as a long term investment promising rich dividends towards the end and having a certain lock in period liquefiable with minor adjustment. Certain figures are often quoted without normalizing for contextual realities like state of economy, cultural backdrop and number of seekers etc. It is often said that 7% of the GDP will be adequate for the purpose largely on the premise that some of the developed countries have this allocation. We cannot simply take this figure and should remain open to a larger allocation while working for innovative ways of education which sustain themselves to varied extent. Thus the youth involved could be made to work and produce or man the services of the campus ensuring affordable cost of operations. The goal of any policy of education should be to include all for education and to be on par enabling provisions will have to be made to remove disparity.

Economics of education:

At around the turn of this century, two individuals from the corporate houses joined hands in proposing the "Corporatization of Education" for sustainability. I respect the concern for sustainability but find nothing to respect when it comes to considering education as 'non-profit good' and distancing the state from making any inputs into it. The fact remains that we had barely reached a meager 2.4 % or so of GDP allocated to this sector. This was a blatant show of money power to achieve a reservation for the moneyed people in education. It is this sector that loudly voices its concerns when the Legislature and Judiciary issue orders to implement reservation for the weaker sections of the society and exempt themselves from such directions by saying it might result in compromised quality of materials and services. We should learn from the experiences of the Southern states particularly Tamil Nadu where reservations have resulted in good quality works cumulating in development of the states in addition to the intended social reforms for parity.

Nevertheless, innovating models should be made to ensure resource generation from within by productive activities of those seeking education but not having the resource to sustain the same. Some of these activities could be (a) fabrication and manufacture of consumer goods e.g., embroidery, draping, carpentry, smithy, brewing, baking, dairy processes, etc, (b) manpower-based power industry, (c) refurbishing of durables like furniture, building materials, fittings and (d) safe recycling of waste materials. We need to assess the amount of new kinds of wastes accumulating with the advent of new and newer generation of computers and abandoning of the old generation instruments. An individual's productive capacity can be equivalent to a certain capital immediately but the real value human capital still remains in the making and would eventually surpass all the direct and indirect investment that might have been made in its production.

What shall we teach?

An educated person must have independent scientific grasp of the perpetual human curiosity surrounding genesis. It is important to ask the questions on the cause of all existence and take only a rational view of the creator. Hence the issue of Origin of Matter and Origin of the Universe must be taken as important scientific knowledge with the educated. It is important that the battalion of anthropomorphic Gods have been created by human minds in all the mythologies. Why does human mind get drawn towards such creative though fictitious imagination is a question that must be asked and answered. Hence Theology and Mythology of various religions also must be given their share in our programs. It will serve no purpose to avoid discussions on these topics. It is equally important to understand that creation of materials characteristic of living systems does not require any divine intervention and that if we just went back on time scale long enough, all living systems seem to have descended common ancestral beings. This will help in appreciating commonality and essential equality of all living beings. It is therefore necessary to learn about scientific experiments that have tried to create living systems de novo. Origin and Evolution of Life should be a subject for major discourse.

Orientation for employment

As has been surmised education needs to be freed from personal compulsions for survival. However, this is not to ignore survival itself. Hence each program should intermittently offer possibility to acquire employable skills of diverse kinds. In fact when one talks of praxis, many of these skills are naturally acquired at an early stage. Yet there may be a need for advanced discourse and hands-on training for emerging areas of activity and there should be proportionate opportunity for graduates to take a diploma of one to a few semesters. It will be unrealistic to imagine that all educated people become teachers. Certain skill can be part of formal curricula for sciences e.g., electronics, computer programming, routine clinical diagnostics etc while others like hospitality services may require separate treatment.

The oneness of all scientific knowledge

It needs to be illustrated and told to the students that there are no real divides between different disciplines of science. These are only created for convenience of learning methodology. All academic pursuits originate at common points and tend to converge again towards the end. Science by its very nature cannot be restricted to disciplines. Some issues that need be highlighted are the physical basis of form and function in biological systems, material basis of inheritance, genetic basis of organization, physics of vision, photobiochemical phenomena and life, the EMR spectrum and its interaction with non-living and living systems, Sun as the basis of most of life on Earth, geochemical history of rocks and what they tell us about history of life on Earth, the size and age of the Universe, evolution of the Universe, the linear and nonlinear functions, transition from space-less timeless pre-existence to the present.

Keeping the people close to ground reality beyond formal education

To work with one's own hands is often considered demeaning among orthodox Indians. To attend to works like sanitation, laborious construction related works etc are considered lowly jobs. This is part of the cultural inertia which needs to be broken and people need to be held to ground by participation in all kinds of works and services for a certain period annually. Many of these activities will generate value or produce goods and services with their own capital equivalence and can be rationally normalized in terms of any resource allocation made for this period annually. I am opposed to thrusting any model on ourselves without making necessary correction for our socio-economic-cultural realities. Yet I remain open to learning from experiences anywhere on Earth. The Swiss have one such activity which is called 'Compulsory Military Service'. It should be noted that as a nation they have not participated in any war for the past five hundred years while maintaining their territorial integrity among neighbouring countries like Germany, France , Italy and Austria. Only a small part of this program relates with military, as much as would suffice to keep awareness of arms and ammunitions. Most of the time is spent in attending to routine services like cleaning of a Railway station, a certain segment of sewer system, repair of damaged portion of any public facility etc etc. We can design similar programs as a component of their post-educational activity. This helps inculcating the sense of parity and protects the dignity of labour.

Ethical and civil behaviour:

While there can be no universal definition of right, wrong, good or bad, the society has certain norms for acceptable behaviour and they should remain with continuous corrections/reviews incorporated with

changing time. Education can beware the students of this expectation and why one abides by the humanly developed norms. Bertrand Russel in "Education and the Social Order' recounted "I found one day in school a boy of medium size ill-treating a smaller boy. I expostulated, but he replied: 'The bigs hit me, so I hit the babies; that's fair.' In these words he epitomized the history of the human race."
Since treatment meted out to an individual is likely to be repeated by convenience, there has to be a mechanism for immediate resolution of problems faced by the disadvantaged. In addition, the attitude "everything offered in public domain can be destroyed without a hitch" must be replaced by "everything offered in public domain belongs to me and I belong to the public domain myself" for a good social behaviour without compromising one's individuality.

Learning from Nature:

It has been mentioned in the opening paragraph of this note that education the way it has been has become a stereotype. Perhaps any single accepted system will eventually be viewed as a stereotype. Nevertheless, the vast repertoire of information contained in each display of Nature will take much longer to be qualified like that and hence the link with Nature must be kept intact in all learning and teaching processes. This is the repertoire that best ensures spontaneity of imagination and an encounter with the secrets behind each display.

Nature teaches more than she preaches. There are no sermons in stones. It is easier to get a spark out of a stone than a moral. –John Burroughs

Positive approach:

The phase in human civilization we are witnessing is full of many alarming and sometimes frightening changes. Global warming, the looming catastrophe, the exhaustion of natural resources, fast extinction of many species, general pollution of soil, water and air, the violent extremist approach to problem solving are just some of the realities affront us today. While dealing with these, we must also highlight the most important lesson one can take from biodiversity which is multiplicity of ways to survive and prosper and hence the hope one has of surmounting the problems that would in any case arise. In our system of monitoring progress we must appreciate students' perception of a subject than marking everything at variance from established doctrine as wrong. Creativity is a blessing of Nature to humanity and in fact to all that lives as Pablo Picasso once observed "All children are artists. The problem is how to remain an artist once he grows up."

The lessons in failures must also be brought out since "Failure is instructive. The person who really thinks learns quite as much from his failures as from his successes" (John Devey)

Need to change the corporate view of the world:

The rise of the corporate in directing the intellectual has been phenomenal in recent times. A real independent mind cannot be influenced by such efforts. Yet those professionally opting to teach for a living may unavoidably get affected. It has to be underlined that knowledge is a socially generated treasure and cannot be covered by an individual's patent rights. In fact all the wealth for that matter is socially generated. We own it collectively but cannot accept individual domination over its use except as a custodian. The corporate of the future may have all the freedom to do what they please but the freedom of profiteering will have to go. WE must remain accountable to0 the society in whatever we get to do. The right to education cannot be hostage to the wealthy. It will have to be opened for all.

It is amply clear that education is one of the most important sectors for human upliftment and welfare. The present system of education serves purposes of a few forces that might have commanded maximal influence in policy making in past. Colonial state and corporate world have been among the most indulgent. It is necessary to objectively evaluate and restructure educational programs to provide for blossoming of the human intellect to a fuller extent while ensuring harmonious coexistence of people with different likings and skills. Education must become people oriented.

PANELS PAPERS

ON

SCIENCE EDUCATION IN INDIA

1- PHYSICAL AND CHEMICAL SCIENCE EDUCATION

041 KUMAR, MALAY SEN And MUKHOPADHYAY, RAJIB (DEPARTMENT OF EDUCATION CALCUTTA UNIVERSITY, DEPARTMENT OF EDUCATION, ST. XAVIER'S COLLEGE, **KOLKATA, WEST BENGAL**). CONSTRUCTION AND STANDARDIZATION OA A TEST ON CREATIVITY IN PHYSICS.

In order to identify and nurture creative talent in Physics, test on creativity in Physics is essential. Hence the present study. Objective of the study is to construct and standardize test on creativity in Physics for secondary passed students, which has sound psychometric and scientific base. The test can be easily administered in higher secondary Physics class without resulting high fatigue and anxiety of the subject group with an aim to ensure a quality science education in school.

Science students of class XI studying Physics in different schools in West Bengal was considered as the target population for this study. From this population through stratified random sampling , a group of 212 students was selected as sample. .Students of different sex (boys and girls) and strata (urban and semi-urban) were the components of the sample.

For construction of the items, different factors and abilities related with creativity as suggested by different psychologists and other eminent researchers were first identified. Then items were constructed accordingly being collected from wide area of secondary Physics curriculum. Through verification of these items by three subject experts (experts in the field of Physics and Education), draft test was prepared. The draft test was initially administered to a small try-out sample group for estimating time limit and correcting content and language ambiguities. The corrected version of the test then was administered on the main sample. From the response of the sample, an elaborate scoring key was prepared following suitable and advanced statistical technique of scoring. Accordingly, responses were scored which ultimately helped to analyze items. Divergent type items were analyzed on the basis of their discrimination value whereas the criterion of analysis for convergent type items were discrimination value and facility value both.

Reliability of the test was estimated by considering internal consistency reliability. Cron-bach 'α' coefficient of internal consistency of the test was computed for this estimation– which was found 0.813 for the entire test.

Inter-scorer reliability was also significantly determined (concerned coefficients of correlation for different items were found to vary from 0.692 to 0.920 in case of divergent type and 1.00 for convergent type items)

Intrinsic, predictive, concurrent, criterion, construct and content validity were significantly estimated.As a measure of intrinsic validity, item-item and item-test correlation were studied and coefficients were found to vary between 0.201 to 0.631 (all were significant at 0.01level). Coefficients of correlation in case of predictive and concurrent validity were estimated as 0.625 and 0.548 respectively. Criterion validity was measured by correlating the rating of students on the basis of their scores in this creativity test with rating of their school teachers on the basis of their creative performance in class. Coefficient of correlation was found significant even at 0.005 level. As a measure of construct and concurrent validity, judgments of professional experts were analyzed.

Mean and S.D. (98.14, 21.13 respectively) of the said test over the given sample were calculated. Percentile and stanine norm were also established to interpret scores.

042 MISHRA, MADHUR MOHAN ¼Lecturer (Phy.) Government Model H.S.S. Barwani) भौतिक शास्त्र का अध्ययन और आवश्यक गणितीय संकल्पनायें (10+2 स्तर पर मध्यप्रदेश के संदर्भ में)

10+2 स्तर पर न केवल गणित और भौतिक शास्त्र बल्कि गणित, भौतिक शास्त्र, रसायन विज्ञान, जीव विाान, कृषि, गृहविज्ञान आदि विषयों में यदि इनके अर्न्तसम्बन्धों को आधार बनाया जाये तो प्रत्येक विषय एक दूसरे की अध्ययन आवश्यकताओं की पूर्ति कर सकेगें।

म0प्र0 में भौतिक शास्त्र का एक स्वतंत्र विषय के रूप में अध्ययन कक्षा 11वी से प्रारम्भ होता हैं। कक्षा 10वी तक इसकी विषयवस्तु विज्ञान विषय में सम्मिलित रहती हैं जबकि गणित एक विषय के रूप में स्वतंत्र रूप से पढ़ाया जाता है। एक सुव्यवस्थित और विषयों के अन्तर्सम्बन्धों पर आधारित शिक्षण के लिए आवश्यक है कि कक्षा 10वी तक गणित के पाठ्यक्रम में उन सूत्रों, संकल्पनाओं एवं प्रमेयों की जानकारी दे दी जाये तो भौतिकी के कक्षा 11वी में अध्ययन के लिए आवश्यक हैं प्रस्तुत अध्ययन में यही जानने का प्रयास किया गया है कि कक्षा 11 वीं में भौतिक शास्त्र के अध्ययन के लिए आवश्यक गणितीय ज्ञान प्रदान करने में पाठ्यक्रम किस सीमा तक सक्षम है और गणित एवं भौतिक शास्त्र के पाठ्यक्रमों में क्या अन्तर्सम्बन्ध है ?

043 SITA, LAKSHMI (Delhi University, **Dellhi 110007). SENIOR SECONDARY SCHOOL STUDENTS UNDERSTANDING OF CHEMISTRY AT MICROSCOPIC LEVEL: IMPLICATIONS FOR PEDAGOGY.**

In Chemistry, chemical phenomena are portrayed at three different levels of representation, the macroscopic, microscopic and symbolic representations. Experiences at macroscopic level are understood in terms of microscopic interactions between atoms and molecules, and are understood using a number of models. Microscopic interactions are represented symbolically using equations, pictures etc. Hence, students are confronted with the challenge to interpret a variety of representations, abstract and complex models at microscopic level and also understand the relation between the three ways of representation.

Over the past two decades, there have been a number of studies in the constructivist paradigm, exploring students' alternate conceptions in various topics of science. The studies bring out the importance of students' prior knowledge in interpretation of new learning experiences in science. The research has resulted in an interest in the 'content' of science, and also the methods which educators can use to facilitate students in construction and reconstruction of ideas.

As Chemistry educators we are often confronted with strange accounts of chemical phenomena by students, many of the idea seemingly quite sensible from the students' point of view. This paper is based on a research study conducted by me in which students' understanding of the chemical bond and representations at microscopic level were probed in depth through unstructured personal interviews.

This paper describes some of the significant ideas (expressed constructs) of senior secondary school students in chemistry with regard to chemical bonding and interactions at molecular level, which were explored through in depth personal unstructured interviews with students. It was found that students' expressed their idea of bond in a number of ways, a joint, connection etc., and most did not view the covalent bond as a force of attraction. Students continue to use the 'octet rule' to explain bonding at senior secondary level. It was also found that students' had confusion regarding the symbolic and microscopic representation in chemistry. The paper examines the likely sources of students' conceptions especially the textbook.

Some ways for addressing students' alternative concepts in the classroom situation are discussed. The paper brings out the need for teachers to encourage imagination and visualization . The paper also highlights the significance of democratic environment in class where ideas of each student are valued and students get opportuntity to listen, express, debate and justify their ideas.

044 UMAPATI, PATTER And VIJAY, RAYBAGKAR (Vijayanagar College Hospet 57-83201 Karnataka, N. Wadia College **Pune, Maharashtra).** AN INVESTIGATION OF THE CONTRIBUTIONOF TRADITIONAL EXPERIMENTS AT THE UNDERGRADUATE LEVEL TO THE LEARNING OF CONCEPT IN PHYSICS.

Experts in Science and Education have been citing umpteen numbers of reasons for the present dismal state of science education in India. Sometimes they have also offered useful suggestions along with their analyses. It is expected that all those who constitute the formal education system take relevant clues from the analyses and bring about an improvement initially in their individual performances and later at the institutional level through better coordination among the staff. However, there is always a need to review the analyses carefully to decide *what is relevant*. The decision should be based on facts rather than individual perceptions. This is why the authors who are undergraduate level teachers are currently investigating the area of laboratory physics in a typical traditional Indian college environment.

They are focusing their attention on the causes of lack of proper understanding of general physics among undergraduate students of colleges falling under the jurisdiction of Gulbarga University. A similar study was carried out earlier on the undergraduate students under the jurisdiction of Pune University by one of them[1]. It was found that the existing levels of subject communication were rather poor. A set of new simple innovative experiments was designed and tested as a remedy and found to be quite useful. Therefore, the authors have decided to undertake a similar exercise on students from another state of India to check if the obstacles in subject communication and the remedy could be similar. If the observations are similar, the decision making authorities such as the members of boards of studies in Physics in various Universities could then be recommended a concrete course of action as a reliable remedy based on studies involving wider population of students and teachers.

Owing to the limitations of students reflected through class tests and regular university examinations including poor subject communicational skills observed over a period of time, tailor-made questionnaires have been designed to work as diagnostic tools. These are based on the traditional physics experiments done by the students during graduation. These would hopefully act as more reliable and realistic research tools compared to others that have been employed elsewhere in totally different environments.

The present paper discusses some factors related to the traditional experiments that contribute to learning of basic concepts in physics as manifested through a statistical analysis of the items in these questionnaires. These observations might help fellow college teachers and experts in formulating appropriate corrective measures for near future.

02- BIOLOGICAL SCIENCE/LIFE SCIENCE

045 KUMAR RAJESH (Scientist Central Institute of Mining and Fuel Research, Digwadih Campus P.O.- FRI, **Dhanbad-828108, Jharkhand).** BIOLOGICAL SCIENCE EDUCATION IS A KEY TO DEVELOP THE PERSONILITY OF STUDENTS.

When a child starts with A for Apple, biological science education starts. In pre matriculate classes, education is given on all subjects like Hindi, English, Mathematics, History, Geography, Art, Agriculture Science, Civic Science etc. A regular and concrete course in Biology starts in 9th class. Biology which covers Botany, Zoology and other Life Science matters become part of Matriculate classes. As the time is passing, many changes are coming in the syllabus of the subject. In High School under the subject of biology two subjects viz. Zoology and Botany are studied together in one class with a practical class. In 10+2 i.e. intermediate classes Zoology and Botany are separate subjects but taught in same class with a practical class. In graduation level Botany, Zoology, Microbiology, Environmental Science all are separate subjects taught separately with separate practical class. Biological Science education in due course has advanced a lot. This is the next interesting subject after history in reading what I feel. There are many institutes in India, which are providing courses and doting fundamental researchers on the development of science education. Some of the institutes are a follows:

1. Indian Institute of Science Education and Research, Bhopal
2. Indian Institute of Science Education and Research, Kolkata
3. Indian Institute of Science Education and Research, Mohali, Punjab
4. Indian Institute of Science Education and Research, Pune
5. Indian institute of Science Education and Research, Thiruvannthapuram.
6. Postgraduate Institute of Medical Education& Research, Chandigarh
7. Regional Institute of Education, Bhubaneswar- 751022, Orissa under National council of Educational Research and Training, New Delhi
8. Department of Post Graduate Studies and Research in Biological Sciences, Rani Durgavati University, Jabalpur
9. Mody Institute of Education and Research, Sikri, Rajasthan

Human beings are surrounded by variety of biological organisms. All these biological organism affects the social/ physical/ cultural development of each and every human being. Knowledge about plants in important for eating and life saving from many diseases. Knowledge about the microorganism is necessary to use many chemical processes, which are beneficial for leading a good industrial life. Microorganisms are causes of many diseases. Knowledge of sanitation and infection from the microorganism improves the quality of life as well as the longevity of life. Pet animals are useful but some time they may be cause of many diseases. Knowledge of these things can enhance the longevity of human beings. There are some plants which have cultural value. Many plants are grown for enrichment and prosperousness. Japanese bamboo plants are kept in the house tied with red ribbon for happiness and developing good environment. But where is education for all these things. These days' new diseases of viruses are being discovered like bird flue and swine flue. Since these diseases have no proper remedial measures with medical departments. Precautions are the major remedy. But where is proper education. Gifting of flower and plants has some value attached with it. Rose flower is for love but thorn in it, is to be avoided, this is disturbing element for love. Thorns and spikes are disliked. The role of biological science education in human life is immense, this is to be thought and learned to improve the quality of life by each and every individual. Worshiping of plants like people, Tulsi, Vat, Kela and many others have developed a sense of feeling of god in it. We are not worshiping these plants without any reason. We are doing it for some gratification is fulfilled. It is also possible that some of the expectations of some people are not fulfilled after the complete worship of a particular plant. In that case it is told that, there was some lacuna by the worshiper. Repeat the same till you are not blessed with the expected need from the God/Goddess. These things have no role in biological science education. But in fact, we have so far not developed the instrument by which this particular thing is observed/tested/tried/evaluated. This is the lapses in our technology.

In earlier days education was for knowledge and personality development. But now education is for pursuing carrier and livelihood. In earlier days education was confined some class or group of people, but new education is open to every one. These days drop out of children in schools are more, to restrict it, to a some extent the Forest Department of Jharkhand state has come forward with some incentives for the children, so that attendance of students could go up in schools.

Polities in Schools, Colleges and Universities are also factor to boosts up/ boosts down of the Science Education. Proper representation of every class, group, communities in teaching, and other academic and administrative post avoids resentments and also for balanced development of all classes /societies/ communities in the Villages, Blocks, District and States. These days science is being educated through the help of Employment News. Every issue of employment news bring some detail information on one subject as a carrier and give information on facilities available for courses. Hindi News paper Hindustan also brings full page information under "Nai Deshain" in English it is called educational friends.

Not full filling the post of teachers in schools and colleges also hampers the progress of education. If the health service is free for all citizens in India and is cared by Department of Health. Then why education can not be free for all. Private schools are mush-rooming for earning huge amount of money from the rich people. In these schools/ colleges education is minimized but fashion materials and modern equipments are maximized to attract the students. These two things in private school colleges have devalued the government schools / colleges. These things be checked and controlled for better science education in students.

046 MOHAPATRA, ANIMESH K (Zoology, Regional Institute of Education NCERT **Ajmer.305001**). A STUDY OF EFFECTIVENESS OF COMPUTER ANIMATIONS AND ILLUSTRATIONS IN STUDENT'S ACHIEVEMENT IN MOLECULAR BIOLOGY.

Molecular biology is one of the cornerstones of modern biology. The study of molecular biology exposes students to a discipline that has applications in medicines, agriculture, forensic science and the pharmaceutical industries. However, molecular biology is generally regarded as very difficult to teach and to learn. In molecular biology, students are exposed to many concepts and processes at both the macro and molecular levels of organization. Student's difficulties in understanding concepts and processes in molecular biology emerge mainly on the molecular level as a result of the emphasis on minute details and abstract concepts.

This study integrates two leading research areas in science education today: students understanding of molecular biology and the use of computers in science education. The main objective of this study was to explore whether the use of computer animations and illustrations at senior secondary level can contribute to student's understanding of concepts and processes in molecular biology. Biological science students of class XII were divided into three groups- one control and two experimental groups. The control group students were taught molecular biology in the traditional lecture format, students of one experimental group were taught by using illustrations and the students of other experimental group by using computer animations. The results of pre and post-tests showed that students understanding of molecular biology improved substantially in both experimental groups. However, the open ended questions revealed that the computer animation activity was significantly more effective than the illustration activity, especially while teaching dynamic processes like replication, gene expressions etc. The findings also suggest that computer animations can serve as a vehicle for students to generate mental images.
Key words: **Molecular biology, abstract concepts, replication, gene expression.**

047 "Sharma Nawal Kishore (2 श्रीराम, कालोनी, अंकपात मार्ग काजीपुरा, उज्जैन म0 प्र0 456006) "Mendel's — Low—Machine"

उद्देश्यः—

(1) जीव विज्ञान के विद्यार्थियों का आनुवंशिकी एवं उसके मूलभूत विद्धान्त सुगमतापूर्ण इस मशीन द्वारा समझाये जा सकते हैं।

(2) प्रस्तुत मशीन का प्रयोग पशुपालन, संकर प्रजातियों के विकास एवं कृषि में उन्नत संकर बीजों के विकास आदि में किया जा सकता है।

(3) इस मशीन द्वारा एक ही प्रजाति के विभिन्न गुणों वाले प्राणी अथवा वनस्पति के क्रास करवाने पर होने वाले परिवर्तन के अध्ययन में किया जा सकता है।

यंत्र संरचनाः—

(A) **डिमांस्ट्रेशन बोर्डः—** यह यंत्र का प्रमुख भाग है। यह अपने नाम के अनुरूप एक मानीटर की तरह कार्य करता है।

(B) **स्विच बोर्डः—** इस भाग में विभिन्न स्विच लगे हैं जिन पर कोड लिखे गए हैं।

(C) **परिणाम तालिकाः—** इस तालिका में संक्षिप्त विवरण सहित परिणाम की जानकारी दर्शाई गई है।

कार्यप्रणालीः— यह यंत्र विद्युत एवं बैटरी दोनों द्वारा संचालित किया जा सकता है।

03- ECOLOGICAL AND ENVIRONMENTAL SCIENCES EDUCATION

048 ALEXANDAR, R. AND POYYAMOLI G. (Dept of Ecology and Environmental Sciences, **Pondicherry University, Puducherry**): A CONCEPTUAL FRAMEWORK FOR EVOLVING/IMPLEMENTING/MONITORING ENVIRONMENTAL EDUCATION FOR SUSTAINABLE DEVELOPMENT AT SCHOOLS/NEIGHBOURHOODS

Environmental education has been identified as an important tool for encouraging students and people to make the changes needed for sustainable development. Current natural resource pattern is unsustainable that's why the sustainable development has emerged as an alternative. This paper describes a conceptual framework for an experimental action oriented research to assess the student's behavioural attitudes/actions towards environmental problems before/after implementation of environmental education for sustainable development programme (EESD). In the first phase pre-impact assessment will be done in order to assess student's knowledge, understanding, behaviour, attitudes, and actions towards environmental problems for the evaluation of students learning, knowledge, understanding, and applications about environmental issues by using discussions, debates, essay competitions, field trips, special programmes and systematic assessment of environmental quality (quality of drinking water, air, solid waste management and bio diversity inventories in the study areas) by closely involving school children. After implementation of EESD programme the post test (impact survey) will be conducted.

049 ENGINEER MEHER, H. (Bose Institute, 93/I, APC Road **Kolkata 700009**). THE INDIA SCIENCE REPORT.

The first ever India Science Report was published, in 2005. Dr M S Valiathan commissioned it in his capacity as President, INSA. Its Foreword, written by Dr R A Mashelkar in his capacity as President, INSA, tells us that the Reports scope was very wide: it was full of phrases like, "…being brought out at an opportune time. India's prowess in Science & Technology was recognized just last month in a first ever cover page story on an Indian S&T by New Scientist"; "….is becoming a major global knowledge production hub with over 150 foreign companies setting up their R&D centres…", "…. move from the path of 'imitation to innovation' "; "….first signs of reversal of brain-drain are visible" etc. The report dealt with three topics: Science Education, Human Resources and Public Attitude towards Science and Technology. Four years later, we can ask whether the Report has had any influence on the ground? How extensively has it been discussed by science teachers and by the policy makers who make up the main workforce of the country's science education? By India's parents? In the print and electronic media? The questions are relevant. Any report on the state of Indian science, particularly the first ever such report in the now more than half a century old First Indian Republic, and in the 21 st century, is meant for everybody. I shall review its main findings. Its last section, "Looking Ahead", refers to the future. That future is here. Where does the country stand today in the matter of educating its people in science?

050 GUPTA, SAURABH and BOOJH, RAM (Department of Geology, University of **Lucknow, Lucknow 2260017**, Division of Ecological and Earth Science, UNESCO, **New Delhi- 110029**). ENVIRONMENTAL EDUCATION FOR HEALTHCARE PROFESSIONAL WITH REFERENCE TO BIOMEDICAL WASTE MANAGEMENT-A CASE STUDY OF A HOSPITAL IN LUCKNOW, UTTAR PRADESH.

Health care is one of the fastest growing sectors in India undergoing rapid transition. The waste generated from healthcare establishments are posing serious threat to the environment and the people associated with it such as healthcare professionals, workers, patients and the general community. This is

largely due to the lack of awareness and knowledge regarding biomedical waste handling and disposal both in public and health care workers. Healthcare professionals, are the key actors in environmental health practices and play an important role in providing health care services ensuring improvement in environment and quality of life. Environment education of healthcare services particularly in the management of the biomedical waste. Healthcare establishments have direct impacts on the environment, and health of the citizens as well as healthcare professionals. The present study analyzes biomedical waste management system in a Lucknow hospital with special reference to Environment Education. The study was conducted through appropriately designed questionnaire, surveys and interviews with the hospital administration, doctors, nurses, technicians, personal involved in the management of generated wastes, patients and the general community. Observation techniques were also used to verify the authenticity of the information given by the respondents. Samples were taken through a pre-test phases. The results reveal that 58.3% respondents (including40%) were aware of hazards of biomedical waste as well as the biomedical rules and have indeed training programme on it However paramedical staff had poor knowledge about the subject. Majority of respondents (91.6%) thought that biomedical waste management is teamwork and no single class of people is responsible for its safe management. Some 33.3% of the respondent believed that safe management would increase the financial burden on waste management. The study concludes that concerted efforts are needed to evolve a continuing education programme for in- services staff of the health care establishments to make them aware about the need to safe and effective management of biomedical waste management. There is also need to include environmental health and waste management contents in the formal and non formal education systems in the country. Though, students from medical, dental and nursing courses have biomedical waste as part of their curricula, their practical skills in collection, handling and disposal of wastes need to be strengthened by improving the overall performance of all concerned including patients and visitors to the hospital.

051 JAISHANKER, R (School of Ecological informatics, Indian Institute of Information Technology and Management- Kerala, Nila, Technopark Campus, Kariyavattom **(PO), Thiruvananthapuram 695581 Kerala**). ECOLOGICAL INFORMATICS- METAMORPHOSING PEDADOGY OF ECOLOGICAL SCIENCE IN INDIAN

Ecological Information is a transdisciplinary subject that integrate ecology, computational sciences, information and social sciences in order to improve our understanding of ecological processes and expand socio- ecological theory to integrate the Earth's natural systems, human values, health and well-being.

Pedagogy of conventional ecological science, especially in this part of the world is predominantly quasi- quantitative, with more isolated, linear case studies. Ecological information initiative at the Indian Institute of Information Technology and Management- Kerala (IITM-K) natures a wider perspective and recognizes that solutions to ecological challenges are not necessarily confined linearly within its conventional sphere. The academic exercise in ecological informatics at IITM-K, leading to M.Phill. degree is designed to overcome the common deficiencies viz. rudimentary computational capability, informatics skills and aloofness from social issues that are prevalent among students pursuing ecological sciences in India.

M.Phil. in ecological informatics is a yearlong intensive academic programme, where the students spent the first half at IITM-K plugging the aforesaid deficiencies before proceeding to one of the participating institutions to carry out a research project or complete a pertinent review and write a thesis. This programme is a steeping- stone towards a successful professional career in ecological and allied sciences. The paper present a narrative description of the academic programme. The author believes this initiative will constructively metamorphose pedagogy of ecological sciences in India.

Key Words: Ecological Informatics

052 JAIN, NIDHI (Divya Jyoti Jagrati Sansthan, Plot-3, Parwana Road, Pitampura Extn. **New Delhi –110034).** MAINSTREAMING SPIRITUALITY IN ECOLOGICAL AND ENVIRONMENT SCIENCE EDUCATION.

The negative effects of the anthropogenic pressures on Nature are quite conspicuous and have already rung alarming bells. One such consequence is 'Global Warming' or climatic change. Offshoots of global warming are also not far from being noticeable– rise in sea level, ozone loss aggravation, extinction of species, increase in oceanic acidification, increase in pests, etc.

Besides this, toxic wastes persistently emitted through our so-called archetypes of civilization– industries or commercial units– are polluting the vital components of our existence: air, water, and land. Recent surveys affirm that about 50 to 55 thousand chemicals are explicitly poisoning our natural sources of water, while our general water treatment plants identify and separate only thirty of these contaminating chemicals. Every year, more than one thousand new chemicals are extended a warm welcome to the environment, water-resources in particular. Our latest, hybrid, and chemical-based measures of farming have added their lot to infect the potential land and its direct/indirect offspring– flora and fauna. Pesticides, fungicides, insecticides, herbicides, etc. are proving to be highly venomous to the eco-system and earth as a whole.

053 KAUL, M.K. (Biodiversity & Applied Botany, Indian Institute of Integrative Medicine, CSIR, Jammu J&K, India): SCIENCE EDUCATION AT CROSS ROADS IN INDIA AND ENVIRONMENT SECTOR AT SHARP EDGE.

During the last decade we have noticed an alarming trend of lesser number of students opting science at undergraduate level. A study on Decline of Science Education in India conducted by Garg & Gupta (2003) shows that at 10+2 level (12^{th} class) the priority for pursuing science is declining, while for accounts and economics it is increasing and students opt for science only with an eye of professional courses like engineering and medicine. A comprehensive document on Indian Science Report prepared by National Council of Applied Economic Research (2005) outlined many reasons for decline in interest of students towards science education. At class 6-8 level, 22% students want to pursue pure science at higher levels, yet when it comes to students in class 11-12, just 13.4% want to study pure science at graduate/post-graduate level. However, the interest in all types of science education does not decline much and falls in the range of 57-60%. One of the main reasons is that the career opportunities in pure science is far less when compared to professional courses.

A country as diverse as ours needs a holistic rather than piecemeal approach in organizing curricula to help students at primary level of education for thematic understanding of scientific processes to inculcate scientific temperament at grassroot level. As the students go up the educational ladder, an integrated approach towards science education can help in retaining core concepts and compartmentalization will encourage mugging-up the answers accurately for better scores in examination. Some of the following strategies may help to achieve the goal:

- Promoting hands-on training for integrated science education
- Promote self-learning mechanisms
- Encourage e-learning and e-assessment, discouraging rote-learning

- Periodic assessments, no annual tests
- Modernising libraries and laboratories
- Use of scientific movies in class rooms
- Communicating through scientific experiments
- Encouraging field trips for effective understanding
- Training teachers for regular skill upgradation

These are exciting times for scientists, teachers, universities and scientific institutions to face the challenge and an opportunity for rethinking and critical examination of science education in India. Green pledges of policy makers warrant focus on problems related to environmental sciences. A comprehensive approach for greater coordination between regulatory and policy-making agencies needs to be discussed at length in forthcoming Congress.

054 MISHRA, ALOK (Homi Bhabha Centre for Science Education Tata Institute of Fundamental Mumbai). **VULNERABLE STATUES OF SARUS: A SOCIOCOLOLOGICALPERPERSTIVE.**

India is the main abode of world's tallest flying bird called the Sarus Crain. Their population, how ever, has been experiencing a steady decline over the past few decades .Several factors are believed to be responsible for this. Alterations of the landscape to agriculture leading to habitat loss and other socio-ecological factors are the main reasons of this declination. In this presentation you will be introduced to some of the features and current status of this famous historical bird

055 NUTAN, BHARATI (56, Nagin Lake Apartments, Paschim Vihar, Peeragarhi, **New Delhi 110087):** ECOLOGICAL NETWORKS.

Mobilizing grass-root movements to preserve local ecology by sharing know-how through ICT resources is a concern with the sensitized society.

The possible solution to general indifference towards environment perhaps is with the youngest of the generation as much as it is with the older mature citizens of the world.While school based curriculum creates a conceptual clarity about the immediate environment of a community, ICT based sharing offers a method to combat the imbalances in shared responsibilities.

Both school environmental science curriculum and documented reports on local action groups will be analyzed to present a scenario of possibilities to organize local resources for environmental conservation. Selected areas of the Indian region will be explored for data. The data will focus on the community; culture, value and ethics based information assimilated through the environmental science based curriculum.

056 NAIDU, D.V. SUBBA; SRINIVASULU, A.P.; SUBBA REDDY, G.V. AND RAMANAIAH, N.V. (Z.P.H.S. Mydukur, **Kadapa Dist. A.P. 516172).** ENDANGERED JERDON'S COURSER.

The Jerdon's Courser (Rhino pillas bitorquatus) is a small cursorial bird that inhabitats open patches in the scrub jungle. It is nocturnal or crepuscular in habit. It was first described by T.C.Jerdon in 1848. Till 1900, some birds were recorded near Pennar river and Godavari river and valleys. Subsequently, efforts by various ornithologists to record this elusive species were unsuccessful. Special explorations organized by the Bombay Natural History society (BNHS) in 1975 and 1976, did not achieve positive results. This led to the belief that the Jerdon's Courser was extinct. Finally, it was rediscovered near Reddipalli village, Cuddapah District, Andhra Pradesh in January 1986 (Bhushan 1986). The area where it

was rediscribed was designated as the Sri Lankamalleswara Wild Life Sanctuary (SLWLS) for the Jerdon's Courser.

The Jerdon's Courser has been observed regularly only few sites in and around the sanctuary ever since it was rediscovered except sight records, there is no data and current population size or geographical distribution. Further more, very little information is available on the ecology and habitat requirements of the Jerdon's Courser (Bird life international 2004).

Since the Jerdon's Courser is believed to have a small and declining population, it is categorized as "critically endangered" by Bird life International, and also in the IUCN Red list, further more, the J.C. it listed under scheduled of the Indian Wild Life Protection Act 1972. and more importantly, it is considered as priority species under the National wild life Action plan (2002 – 2016) of the Govt. of India (Ministry of Investment and forest, 2002).

The overall objective of this project was to undertake on J.C. this project envisages to create an awareness about the deterioration of the J.C. and determine the various qualities of the bird ecology and new habitat's which have not been registered previously in any records, with help of the local people and identify current threats to the population, another main aim of the project is the conserve the bird and give it to the future generation.

057 MAJUMDAR, RABINDRANATH (Dept. of Chemical Technology University of **Culcutta 92,** A.P.C Road **Kolkatta 700089).** BEGINNERS SCIENCE EDUCATION IN THE ENVIRONMENT.

The world today is confronted with many crises. The central crises are those of environment, development and education. They are deeply intertwined and are bound to assume specific national character as much of what we know as environment has a national face. Globally, India is at the centre-stage of the crises. As a nation, we are critically poised to get them over in our own integrated approach.

The links between environment and development is too well known to be elucidated. And it is better known to the world's rich and the corporate who pursue their businesses in the name of 'sustainable development' and undertake 'green-washing' activities in the guise of 'corporate social responsibility'. But the question is, can India afford to stick to the course of development followed under LPG (Liberalization, Privatization and Globalization)? Can we afford to lose the kind of fertile land that was to be used for the Tata Motor's Nano car without jeopardizing our food security? Can we afford to allow rampant misuse of groundwater by Coke-Pepsico or by the Sponge iron factories in Chhattisgarh, Jarkhand, West Bengal and elsewhere depriving the farmers and the people in those localities of their life-supporting drinking and irrigation water?

India has a population density of about 330 per sq km, the highest among the countries with significant world environmental impact. Those in Brazil, the US and China are 22, 31 and 136 respectively. And WB has a population density of 940 per sq km! Our environment is already under severe stress. The per capita environmental resources (land, water, forest, biodiversity, air) are among the lowest. This is already abysmally low for the poor in India. Depriving them further and allowing the national and international rich corporate players to grab, control and capitalize our environmental resources is against any human right, right to life and livelihood, any sort of right to environment and all that is demanded by national objectives and ethical principles.

It is also squarely recognized that there cannot be any better investment than in education. We are already within the UN decade for Education for Sustainable Development. National Knowledge Commission of India has also focused on issues on education for 21st century India. In spite of all these, sorts of environmental education have been thrust upon schools and colleges in India. It may be helpful for national and global corporate to continue to function in their chosen mode but seen from the requirements of the common people and those of environment of India such education is little more than farce. It is simply reduced to another subject like English, Mathematics, Physics or Sociology. It is neither effective nor conducive to any education. It manifests the old philosophy of treating the learners as containers of infinite capacities for whatever elixir of knowledge poured onto them by the teachers in the classrooms.
If we care to look into the lives of women and men who matter in human society, we may be able to notice

that, notwithstanding formal training, they are always 'self-taught'. But that's not really an apt description; they are, in fact, educationally nourished by their environment- nature and people- they meet and interact with, especially during their early years of life.

In the present day context, we lay much stress on acquiring skills right from the beginning without the slightest regard to attitudes and values. Not really so, we make the children learn to compete and hate, learn to aspire for making quick money, getting at the top defeating others by whatever means. They learn to cram and copy without interest or pleasure; love, affection, empathy elude them. They fail to experience the most useful tenet in their lives - sharing happiness and pleasures actually magnify the achievements and sharing sorrow ness and grief reduces the burden. Our education is to be reset to stand erect on two legs on the Indian soil. This is of prime importance in science education too.

The two great men of India, Mohandas K Gandhi and Rabindranath Tagore, could recognize it and, not content with only preaching, they also ventured to set examples. India praises Gandhi and Tagore but refuses to accept them in planning and framing national education.

Children's education in India can possibly take the right course by following Tagore and Gandhi and building upon them with even the most modern knowledge and techniques but not ignoring the traditional knowledge and wisdom. The right education must begin *in* the child's own environment. It is cheaper and easier. 'Environmental Education' or 'Education *on* Environment' is alien; education *in* environment is smooth and natural, entertaining and substantial. The child is part of nature. If we want to preserve our environment in the most productive condition for generations to follow, if we want really to pursue the most appropriate course of development (call it *sustainable* or whatever), it's high time we see the reasons and follow suit. Just as the stability of a forest is indicated by sustenance of species variety, the identity, stability and sustainability of a nation, such as India, is ensured by preservation of richness of its variety. How can we accomplish that without founding our education in our very own environment?

With India taking such an integral view and commensurate determined actions, the poor of the global south, now severely threatened, will have a mission to live and fight for and pave the way to sustained world human development.

Menon Usha (): Science Education - Cognitive Conflict or the Splicing of Signifiers

Meaning emerges from a practice and words or other signs get their meaning form the discourse in which it is embedded as a part of the practices. Teaching of science menas the teaching of scientific practice with its own discourse and meaning. One of the problems in the teaching or science relates to the fact that while the referents remain the same the meaning of the same words change with the changes in the scientific practices, as for examples in the case of the word atom

In the case of school science we have to deal with the fact that many of the scientific terms have everyday meaning which are at variance with the scientific meanings. The words 'hot' and 'temperature' can be understood as signs situated within practices such as the following. Someone develops a fever, you touch the forehead and use the thermometer to confirm accurately whether the person is running a temperature'. One can clearly see that the signifies 'hot' and 'temperature' get their meaning form being part of such practices. The sensation of feeling hot and recoding temperature are linked to one ontological reality. Now the question is whether this meaning which the child brings into the class-room can be changed by exposing the child to text such

058 RYNGNGA, P.K.(North Eastern Hill University, **Shillong 793003):** ENVIRONMENTAL EDUCATION, AWARENESS, EDUCATION & TRAINING.

The environmental damage already inflicted due to alarming on-going population explosion, rapid movement towards urbanization and industrialization, increasing needs of energy and fast scientific and

technological advancement cannot be reversed unless there is collective thinking, will and effort. This call for public awareness and participation for bringing about an attitudinal change and finally restricting further damage to the environment. Effective implementation of environmental management and conservation programmes depends on education, awareness raising and training in the relevant areas. Without an understanding of how to conserve natural resources and the compelling need to do so, few people would be motivated to participate actively in programmes on environmental conservation, Environment education and awareness thus assume critical importance.

In the light of it, the present paper will emphasize on the importance of environmental education in the society so that environmental degradation can be stopped. The paper will further discuss the environmental education, awareness and training' as an important scheme for enhancing the understanding of people at all levels about the relationship between human beings and the environment and to develop capabilities/skills to improve and protect the environment.

059 RAMKRISHNA, V PRASAD, R.V.; JAMUNA, K.V AND PATIL, SUNIL KUMAR (Department ofAnatomy & Histology, Veterinary College, Hebbal, Bangalore 560 024, Karnataka, Mob. No. 09741547752). PLASTINATION OF BIOLOGICAL SPECIMENS BY RECYCLING ENVIRONMENT POLLUTANTS (SOLUTION FOR POLLUTION ERADICATION.

Protection of environment is directly related to environment pollutants. Plastic teacups and thermocol which play pollution and hazardous role in environment can be utilized under pollution eradication programme. Earlier biological specimens were preserved in 10% formalin solution, which is irritant to eyes and also carcinogenic to the body. It may also cause sterility to human beings. By dissolving plastic tea cups and thermocol in organic solvents the specimens are plastinated and dried in open atmosphere. Arterial corrosion casts to display the vascular system can also be prepared using perfusion technique of recycled plastic solutions. For the first time in India, this department has initiated by recycling plastic teacups and thermocol in the preparation of anatomical specimens and exhibits for teaching purposes. The specimens thus prepared can be stored in the open without undergoing any change. Such anatomical specimens will be beneficial as a life-long teaching aid in teaching institutions and in the preparation of anatomical museum specimens, which can serve for continued education in the country.

060 SUBBA, D.V.; SUBBA, NAIDU; SREENIVASULU, A.P.; SUBBA REDDY, G.V. (Z.P.H.S., Mydukur Kadapa Dist. Andhara Pradesh 516172): **RED GOLD.**

Redsandal tree is a rare one. It is not found any where in the world except in Kadapa District and its surroundings. High quality of Redsandal is available in Kadapa Districts in large areas. This tree has gained much prominence in the world because it has high medicinal and foreign exports importance. These rare and precious trees are being cut down by the smugglers. So these of high quality trees known as "Redgold" are disappearing rapidly. Main aim of this project is to protect and preserve the valuable gift "Redgold" which is blessed by the nature.

The scientific name of the Redsandal is "Terocarpus santalineas". It belongs to the "phyabasi family". These trees are not grown if we plant them in other areas. We found favourable and possible climate for the growth of Redsandal only in Kadapa District and its surroundings only.

Our team visited forest range office at Onipenta and observe the Redsandal woods, which was seized from the smugglers. We estimated its value up to Rs. 2 Crores. Our team observed closely Redsandal wood trees at Balabavi and Mudireddy Palli beats. We also organized a survey one Hundred tribal people and other people living in around the forest area about the high medicinal values of Redsandal

trees and their illegal transport. We also meet forest conservation committee and officers of the forest deportment. and made on interview about the importance and illegal transport of Redsandal.

Our team observed in the survey some new information which had not been registered in the previous service and researches. Redsandal wood is being used by the tribal people to cure various diseases. Some thick liquid which looks like blood flows from the log after few minutes of cutting down the Redsandal tree. After falling on the floor the liquid hardens and changes into thick plate which resembles a rocky slate.

In our project work our team observed more new information like the above more and more scientific researches ought to be done on the Redsandal trees. The tribal people and the people living in and around the forest are not taking any care or interest against the smugglers of Redgold and its illegal transport. So many rallies and seminars were conducted and organized to activate and enlighten the tribal's and others with the help of forest deportment. We received good response from the people. We created a good understanding illegal transport of the Redsandal wood among the students and local people. Though the information given by the officials and paper clippings. We also sent memorandums to the District Collector and D.F.O describing various local circumstances and above topic.We hope that we will preserve and conserve this rare and precious Redsandal trees for our future generations with the cooperation of people, Officers, and N.G.Os.

061 SHARMA, ANIL (Gurukul Vidhyalaya, Bazar Chowk, Lalburra, Distt – Balaghat, M.P.): विज्ञान कितना सहज व सरल।

परिकल्पना – विज्ञान को सरल, रोचक एवं दैनिक जीवन से जोड़ने हेतु एक अध्ययन किया गया। शासन कन्या उच्च माध्यमिक विद्यालय अमोली की छात्रायें अध्ययन में सम्मिलित थी। अध्ययन के परिणाम से यह पता चला कि विज्ञान शिक्षा दैनिक जीवन से सम्बन्धित होने पर रोचक हो जाती है।

062 YADAV, GARIMA (Society for Environmental Education and Development SEED, **Lucknow).** ENVIRONMENT EDUCATION AND COMMUNICATION: ROLE OF MEDIA.

The present paper presents an analysis of the role of media in educating and communicating environmental issues among selected school children and youth groups in Uttar Pradesh. The analysis covers both print and electronic media and how they help shaping people's perceptions on issues like pollution, climate change and biodiversity conservation in selected school children and youth groups. The study used personal interviews, surveys, questionnaires, group meetings and direct observations in eco-clubs meetings, seminars and other environmental events. The study reveals that while the mass media plays an important role in promoting environmental awareness among the people at large, its reach and effectiveness in education is limited due to various reasons. The school children and youth rely more on other education opportunities including materials and aids for keeping themselves aware about environmental issues. The educational opportunities made available through school eco-clubs, youth clubs, NGO interactions, seminars etc play much more important role than media in educating them about environmental issues. Majority of the respondents in the study cited their active involvement in environment action programmes, as the most important factor in shaping their understanding towards environment. These programmes also help them in building practical skills and shaping their attitudes towards environmental issues. The participants of the study group in general felt that coverage of issues in print media was quite superficial. The electronic media particularly the news channels though occasionally highlight local and national environmental issues were hardly of interest to general student community. The channels like discovery, national geographic and animal planet, were found to be informative but respondents were hardly able to relate the contents to their local issues and concerns.

The environmental awareness campaigns organized by media and various NGOs under the

Ministry of Environment and Forests, Govt of India were also helpful in sensitizing school children and youth as well as general masses about major environmental issues and problems like global warming, deforestation and pollution. These environmental education programmes also help in developing leadership skills and critical thinking, towards environment.

4- Medical And Health Sciences Education

063 ANANT, PHADKE (8, Ameya Ashish Society, Kokan Express Hotel Lane, Kothrud **Pune 411037).** MEASURES FOR REFORMING MEDICAL EDUCATION – A WORKING PAPER.

The Concept Note of this symposium states that the Medical and Health Education in India reflects the overall situation in India. I would agree, but would only add that there are contradictory tendencies in this field too and we need to grasp these contradictions in order to plan our intervention. This paper is meant to be a working paper around which a discussion can take place to in order to take forward, various attempts so far on this front.

Current context of reforms in medical education: Since 1990, there has been undermining of the Public Health System and promotion of unregulated private health-care sector. There is increased availability in India, of medical technologies which were hitherto available only in developed countries. However, there has been exacerbation of the basic problems of our health-care system – the widening gap between the haves and have-nots; extreme paucity of health services in the Public Health system on the one hand on the other hand unaffordable services in the private sector whose quality is unpredictable, generally poor along with the increasing exploitation, cheating of patients and violation of their human rights. However the 2004 Lok Sabha elections showed that people want better governance by rejecting the 'India Shining' option. Learning from this and the verdict of the 2009 elections, the UPA government has taken a series of measures like increased allocation for NEGRA, mid-day school meal, and health-care as a response to the electoral verdict. In the 2009-2010 budget of the Central Govt. Rs. 350 crores have been earmarked for the Rashtriya Swasthya Bima Yojana (RSBY) wherein bills for yellow ration card holder i.e. officially poor patients admitted in designated private hospitals, their bill will be paid through/reimbursed through RSBY up to an annual quota of Rs. 30,000/-. When the govt. pays the private hospital's bills, the govt. will have to scrutinize the rationality of the treatment and of the charges levied. Experience internationally has shown that public financing of private hospital bills is the road to regulation of private doctors. More public pressure can be put to push the govt. more in this direction. Regulation of private practice can also move towards regulation of medical education because the ill effects of privatization of medical education are now too obvious –

Private Medical Colleges are churning out doctors who have no clinical experience and govt. medical colleges are churning out graduates who have no good teachers left with them. As of today there is even no discussion about halting privatization of medical education reforming medical education. But Indian govt. will have to put a halt to this most damaging policy of privatization of medical-education. Doctors who have spent from 3 to 10 lac rupees for graduation and from 5 to 25 lac for post-graduation (in some places up to 2 crores !) are bound to levy fees which are unaffordable to even middle class and are more likely to indulge into unnecessary interventions to join the medico-industrial complex in cheating, exploiting people. Given the fee structure that now exists, today Medical Colleges are more and more turning into enterprises for the 'haves' and who produce doctors for the rich people whether in India or abroad. This situation, after a stage, would lead to reactive social explosion. Hence this unbridled exploitation, cheating can not continue for long.

The medical education will have also to change into a much improved system generating doctors who are playing a socially positive role. The basic precondition for such a socially appropriate reformed medical education system is that medical profession stops joining other 'professions' of easy money making at the expense of common people. One of the pre-conditions for this is a ban on private medical colleges which charge fees which are more than the govt. college fees or who demand donations for admitting students. Professional education like Medical Education can not be subsidized or can not draw resources at the expense of primary, secondary education. The expenses have to be largely recovered from students. However, expenses of medical education should be realistically, rationally calculated. Cost of running the teaching hospital and of the clinical staff, land cost should be excluded while counting

expenses for medical education. Secondly, liberal facilities for scholarships, low interest long term loans for all the needy students should be the responsibility of the state.

Measures for reforming medical education: Without loosing sight of this basic prerequisite of building a system of a good quality and socially appropriate medical education, some suggestions have been outlined below for some specific measures to reform medical education in India. These suggestions are based on the discussions in the two Annual Meets of the Medico Friend Circle that have taken place on this issue of Medical Education. After the first MFC meet on Medical Education in the late seventies, the Community Health Cell, Bangalore systematically followed up this issue of reforming Medical Education. This work needs to be revisited and taken forward in the current context. The central govt. is now planning to bring all Medical Councils under one organization and institute certain reforms in medical education. This offers an opportunity to raise certain issues and push certain reforms.

In the context of the above situation, advocates of the People's Health Movement and of other people's movements will have to keep demanding specific measures to make medical-education socially appropriate. I am outlining these measures below for discussion amongst those who are interested in reforming medical education in India. Making these demands has a dual function. On the one hand, these demands are educative for the public. People, at least those working in the health sector should know what kinds of reforms are needed in medical education and on that basis we can build public pressure. Secondly, by making these concrete demands, we can question the position that There Is No Alternative. (TINA) The govt. is less likely to carry out these measures. In that case it will get exposed in the eyes of the people and that will create more pressure for change.

Following measures are needed to reform medical education in India-

Clarity on the objective of medical education : It should be clear that the objective of medical education is to create a basic, socially appropriate doctor. The basic doctor should be quite competent to deal with, mainly in non-hospital setting, common health problems in our society. Graduation should not primarily be a preparation for post-graduation. Such a basic doctor should have a sound grasp of fundamental principles of medical science along with knowledge and skills (both clinical and non-clinical) to deal with common problems in our society. Medical College education should teach self-learning of medicine so that there is learner based Continuing Medical Education after the basic training is over.

Admission criteria: Admission to medical college should be open to paramedics also – say for a nurse who has minimum 5 years' experience. (Career stagnation is one of the important problems of the paramedics.) They can appear for Common Entrance Examination and are given certain grace- marks while preparing merit list.

Special good quality free coaching classes for the reserve quota candidates for helping them to score well appearing for Common Entrance Test. Number of admissions to these classes would be say thrice the number of seats available and would be as per merit lists from pre-medical colleges.

Reservations should continue with a condition of minimum 60% marks. To bring the medical students from the reservation quota on par with open merit students, there should be special free coaching classes for those who register for it. There should be reservation and support for students coming from backward districts with a bond to serve in that area for at least five years.

Training setting, training methods and trainer/trainee relationship: For clinical training about half the time should be spent in a nearby health care outpost. Due emphasis should be given on learning practical skills like wound dressing, minor procedures. (I passed out from renowned medical college, was more than average student, but learnt the art and science of injections, suturing, bandaging etc. only during my first month of internship!)

Medical college teachers should routinely undergo orientation and training in the art and science of pedagogy. There should be system of students giving anonymous feedback and rating about teachers in a format covering different components of teaching and teacher-student relationship.

Nurses, counselors and other paramedics as well as general practitioners should act as guest - teachers for specific topics.

Training should guided by learning objectives. Students should not be burdened with unnecessary information load. The breadth and depth of teaching should not be dictated by Western textbooks since some of the preconditions and concerns of these books are absent or greatly modified by conditions in India. We have prepare learning objectives for each topic and the teaching should be geared to achieve these learning objectives.

Medical College education should become an exercise in training in self-learning of medicine and not merely as learning fundamental principles, relevant knowledge and skills. Medical graduate should be able to access more knowledge later as per need. Learning of medicines should thus be a life-long process and medical college training should be a beginning of this process.

Didactic teaching should be reduced to a minimum. Main emphasis should be on individual and group exercises and interactive session. Lecture notes, soft copies, print-out of Power-Point Presentations to be made routinely available to students. Adequate computer facilities and a quota of free computer time made available to students.

Pre-clinical, para-clinical training: Training in pre-clinical subjects substantially reduced to serve the purpose of producing a basic doctor with sound grasp of fundamental principles rather than detailed knowledge. Pre-clinical subjects should be taught by clinicians-anatomy by surgeons, physiology, bio-chemistry, pharmacology by physicians. Public health angle of various health problems should be taught by clinicians so that students would learn to think in a holistic way. Clinicians will have to reorient themselves to do this.

Cadaver dissection by students should be replaced by students learning from dissected parts prepared by teachers. There should be extensive use audio visual materials and of appropriate life-size models.

Medical ethics, medical sociology, ethics/politics of health- communication etc. should be taught as part of Community Medicine from 1st year. A team of two-three students should be given guided responsibility of interacting with a neighborhood for health communication and counseling. A team of two-three students should also be allotted a bed in teaching hospital for doing guided work of health-education of the patient and of the family and to work as that patient's advocate vis-à-vis the hospital staff

Inclusion of new topics: Some more topics, which, currently are not included in the medical education curriculum, need to be introduced -

- Introduction to principles of complementary medicines officially recognized in India – AYUSH – Ayurved Unani, Siddha, Homeopathi and introduction to the experience of role of complementary medicines, folk medicine in other countries.
- Introduction to science of exercise for attaining, maintaining fitness; fitness programmes.
- Introduction to the role of health professionals in the care of victims of domestic violence.
- Introduction to political economy of health, health care and politics of health care.
- Record keeping, accounts keeping, issuing certificates of various types, complying with legal requirement.

Assessment of trainees: There should be a combination of various tools for assessment after completion of each topic and completion of semester. Tools to be used – MCQ based tests, assessment of short notes, presentations, and of performance during practicals, workshops.

Compulsory Continuing Medical Education: Accredited institutions should run CME courses, journals,

activities on a no loss - no profit bases. Their fees should be regulated. CME can be in the form of internet based inputs followed by MCQ based tests to gain credits. All doctors must earn certain minimum number of credits by participating in various accredited academic programmes or subscribing to one or more accredited journals and gaining credits by successfully completing tests designed by these journals participating in web-based inputs.

(This paper does not deal with post-graduate medical education, its relation with under-graduate education and its impact on availability of basic doctor, family physician.

My thanks to Dr. Shyam Ashtekar for his suggestions on an earlier draft. The usual disclaimer remains.)

064 AGARWAL, KAVITA S. (Kamala Nehru Memorial Hospital, Allahabad). HEALTH SCENARIO IN EAG STATES – NEED TO DESIGN INNOVATIVE HEALTH EDUCATION TOOLS FOR THE COMMUNITY.

The final report of the National Family Health Survey (NFHS-3, 2005-06) threw light on the comprehensive picture of the health, nutrition and population status in all 29 states of the country. In certain areas the health indicators improved like infant mortality has come down, women opted for fewer numbers of children. In EAG (empowered action group) States (UP, MP Bihar, Rajasthan, Orissa), NFHS 3 findings do not show much improvement. Recognizing the importance of health in the process of economic and social development and improving the quality of life of our citizens, the government of India launched the National Rural Health Mission (NRHM 2005-12) to carry out necessary architectural correction in the basic health care delivery system. The goal of the mission is to improve the availability of and access to quality health care by people, especially for those residing in rural areas, the poor, women and children.

Only improvements in health infrastructure do not make people to adopt them. They need to be educated on the best practices. Health education is found to be a good communication method to change people's health practices. According to Alma Atta Declaration (1978), health education is "a process aimed at encouraging people to want to be healthy, to know how to stay healthy, to do what they individually and collectively to maintain health and seek help when needed".

The present paper discusses various health education methods adopted in reproductive health programmes in city slums and villages for behaviour change. The emphasis was on dissemination of health education based on scientific facts. The assumption was that people would act on the information supplied by health professionals to improve health. Various strategies undertaken for health education included – individual counselling, group meetings, role play, folk media performances, verbal autopsy and sharing of findings with the community and family life education in schools, etc. In addition training of traditional birth attendants (TBA) and peer educators were undertaken to demystify beliefs about certain health practices from the community members.

The paper throws light on the development of coherent strategy of health education which must involve all the ways to change behaviour and to recognise that the approach will differ for different behaviour one wants to change. The reliance on one method is likely to lead to failures. A combination of approaches using all methods to change life style and appropriate use of medical care will be necessary. The health education model for EAG states which is emphasized here takes into account the social environment which shapes the behaviour of the individual and the community.

065 DEO, M. G. (13, Swastishree society, **Pune 411052).** CHALLENGES IN MEDICAL EDUCATION & RESEARCH- ORIENTED EDUCATION IN INDEPENDENT INDIA.

At the time of independence India had just 20 medical colleges. Sixty years later the number has increased 13 folds. Numerically, the nation has done well, but in the process the quality of education has suffered affecting in research, the mother of new knowledge. An ICMR survey shows that in 1990 one fourth of medical colleges had not published a single article in Indexed journals. Ten years later (in 2000) the number of medical colleges had gone up from 145 in 1990 to 180. But the number of papers declined from 1115 to 783. Not even 5% of our medical colleges meet global standards. This should be a matter of concern to the entire medical and academic community. Medical education and research in India faces several challenges. (a) Mushrooming of medical colleges (Currently 296 colleges) specially in the last two decades has resulted in gross shortage of resources, both money and trained manpower. Consequently, even the minimum supportive infrastructure is not available in a large majority of medical colleges. (b) India is current going through health epidemiological transition. Non-communicable diseases can no more be ignored. This calls for restructuring of medical education. (c) Medical curricula have remained more or less static for the past several years. (d) Frontiers of medicine and biomedicine are expanding at an unprecedented rate. But tuning of curricula to new knowledge is very sluggish creating a progressively increasing gulf between *what is known and what is taught*. (e) Because of the lack of exposure to current trends faculty feels shy of using modern technologies and writing research proposals. All funding agencies have major programs for medical sciences, but there are very few takers. (f) Finally, medical education and research have been a none-issue for the Government. No committee/commission has been appointed to consider various facets of medical education and research and how to make them globally competitive. On the brighter side medicine still attracts some of the best talent. They should be provided quality education, which may not be possible in the current system. This may be partly achieved through the modality of "Mobile workshop", an *'outreach'* program, which takes new knowledge to students' doorsteps. This highly successful concept, developed by the Moving Academy of Medicine and Biomedicine, could be adopted by our top medical colleges and postgraduate institutes such as PGI (Chandigarh) and SGPGI (Lucknow). Simultaneously, the concept of CMEs for UG should be implemented. These programme would lift quality of education in our resource strapped medical colleges. Declining interest of medicos in research is a global phenomenon. Yet students' enthusiastic response to ICMR Short Term Studentship programme clearly shows that a small sector of medicos (about 5%) is interested in medical research. They should be nurtured by promoting research-oriented medical education. National and Regional Medical Students' Research Conferences that would provide an interactive forum to the UG students interested in research should be regularly organized. Likewise, regional training workshops in clinical and laboratory research should be conducted on a regular basis. A special challenge is how to integrate these new approaches in medical education and research in already over burdened medical curriculum. These issues will be discussed and debated.

066 EKBAL B. (Kuzhuvalil House, Arpookara East **Kottayam- 686008, Kerala).** INFORMATION TECHNOLOGY: IMPLICATIONS FOR MEDICAL AND HEALTH SCIENCE EDUCATION.

The unprecedented growth of the Information Technology and the speed of the arrival of information age has left most of the medical profession and the people at large ill prepared to participate in it and unable to foresee its consequences for patient care and public health. Through the Internet, the public has now access to a growing supply of information on health and disease, often of variable quality and relevance. There are about 100,000 medical websites existing and their number is still growing rapidly. As a result, providing information on health will no longer be the exclusive remit of health care professionals. The quantity of information on the Internet will continue to grow over the next few years, as will the proportion of people with access to it.

In internet the concept of "prevention" and "health promotion" which traditionally implied a formal communication process between the health professional as provider and the consumer as receiver is changing. Though there are a number of discussion forums conducted by committed doctors for patients on the internet health promotion and prevention is changing largely into a communication between consumer and consumer. This means that the original concept of public health as a process of enabling people to increase control over the determinants of health and thereby prevent disease or reduce the impact of disease mostly with the help of the health professionals like doctors is changing.

But despite the obvious benefits, Medical Informatics presents many challenges, both to users and suppliers of the information. The Internet is accessible from most parts of the globe, and access and dissemination is largely uncontrolled and uncontrollable. Such an anarchic situation in this world of centralization of medial control has a democratic potential for decentralised information sharing. The main problem is that the quality of health information available in the net varies widely, from the most up to date practice guidelines produced by leading clinical bodies to out of date or inaccurate recommendations from various dubious agencies including drug companies

It is important to evaluate the claims made for these new technologies by those who seek to profit from them. Just as there is a longstanding symbiosis between the pharmaceutical industry and medicine, there is a newer and consequently less examined relation between medicine and the computing and telecommunication industries. Medical professionals should try to judge the claims of these technologies in the same cautious way that they would examine claims about a new drug. Perhaps more so given that clinicians are far more knowledgeable about pharmacology that they are about informatics and telecommunications.

It is clear the changing nature of information delivery brings with it enormous implications for public health and medical education. There is a pressing need for dialogue with in the concerned public and between the public and the computer and the health professionals to understand the impact of communication and information technologies on the health of the people.

067 GARODE, A.M. (DEPARTMENT OF MICROBIOLOGY DEPARTMENT OF MICROBIOLOGY SHRI SHIVAJI SCIENCECOLLEGE, **CHIKHLI – 443201 DIST – BULDANA MAHARASHTRA**). **PROMOTING WATER AND SANITATION HYGIENE EDUCATION FOR THE REDUCTION OF WATER - BORNE DISEASE**

Water borne diseases are a major cause of morbidity and mortality in the developing world. Of the interventions to reduce the risk of diarrhea the promotion of improvements in personal and domestic hygiene ranks among the potentially most effective. The present paper deals with the study of consultation which considered three types of interventions for improving hygiene behaviours: public health communication, participatory method and promotion through schools. This consultations first identified a set of key hygiene behaviours which if adopted can lead o reductions in water-borne and diarrhoeal diseases. Water supply, Sanitation and hygiene programmes should be community based and designed for maximum participation. Such activities should begin with an identification of what people are already doing, by recognizing the meaning and benefits of these behaviours, and by building upon these in ways which enable people to make informed decisions about possible changes.

068 GANACHARI, M.S And MAHENDRA KUMAR B.J& NIDHI M. ZALAVADIA And SOHAM P. SHAH (Head of the Department, Department of Pharmacy Practice, KLES College of Pharmacy, Belgaum,). EMERGING ROLE OF CLINICAL PHARMACIST IN HEALTH CARE SYSTEM

The pharmacist is no longer only a dispenser, but he has achieved a much more important role in medicine management and an overall healthcare programmer. The profession of pharmacy in India is undergoing a rapid change. Indian pharmaceutical industry ranks 4th in volume and 13th in value in global pharmaceutical market. This expanding pharmaceutical industry requires clinically trained pharmacy professionals who can face global challenges and compete with the multinationals.

069 GUPTA, SIDDHARTHA SHRAMAJIBI SWASTHYA UDYOG INDIA (40 A **Simla Street).** NON-FORMAL MEDICAL EDUCATION: OUR EXPERIENCE IN RURAL WEST BENGAL.

India is a vast land of 32.9 lacks square kilometers harboring a population of above 1.1 billion. About 67% of this huge population lives in the vast hinterland of rural India, deprived of basic sanitation, safe drinking water and primary health care even after 62 years of independence.

The **National Rural Health Mission (2005-2012)** documents have clearly pointed out the dismal condition of healthcare in the rural India. It has highlighted the deficiencies of human resources in the form of gross shortage of doctors, nurses, paramedics, laboratory technicians and so on. In addition, the lack of continued education skill upgradation, adaptation of standard protocols and lack of motivation are also the contributory factors.

At present India have only 7.1 doctors of modern medicine, 7.2 AYUSH doctor (ayurved, homeopathy, unani, naturpathy and siddhai), less than I dental surgeon, and 8.3 nurse per 10,000 population, which is meager in comparison to developed nations. So, the need of Accreditation of Social Health Activists (ASHA) and involvement of Informal Rural Practitioners (the so called quacks) have been given enormous importance in the core strategy and supplementary strategy of NRHM mission.

The **Shramajibi Swasthya Udoyog** is a voluntary non funded organization of doctors and health workers. It is working since 1996 in some areas of rural Bengal to deliver modern healthcare service, specially aimed to the marginalized people. It does not accept any government, corporate or foreign funding to avoid "Policy control" by the donor organization and generates its resources entirely depending on the peoples' Initiative it promotes **rational use of medicines** and provides medical service in disasters.

A very important activity of the organization is to deliver **intensive training for the health workers** to deliver elementary healthcare in the remote areas of West Bengal and the neighboring states.

The training includes anatomy and physiology of human body, history taking of patients, first aid, common ailments and their management, preliminary knowledge of pharmacy, performing common laboratory tests, heath and hygienic protocols, healthcare in disasters etc. General physicians and about 9 specialist of different medical discipline give the training. This training is residential and conducted 2 to 3 times a years at the base hospital of the organization at Chengail, Howrah of West Bengal.

Additionally 1 to 2 days training camps are also conducted in different rural and semi urban areas in collaboration with different social organization, NGO, science clubs etc. Training of informal rural **practitioners** are also done in these camps.

Till date, we have trained above 350 health above 350 health workers from different part of Bengal, Jharkhand & Tripura who were sent to us by different sociopolitical organization working among marginalized people like farmers, unorganized industrial workers, workers in tea plantation and miners. Back home, many such trained health workers have already started clinics for treatment of common diseases, mother & childcare, malaria control etc.

The organization, in collaboration with the **Foundation for Health Action,** regularly brings out **Asukh-Bisukh** (a bimonthly Bengali medical journal for common people and rural practitioners) and **Bulletin of Drug & Health information or BODHI** (a biomonthly English medical journal promoting rational therapy for doctors), for last 9 and 16 years respectively. It also publishes another journal called **Doctors' Dialogue** on the sociopolitical and economic aspects of health.

The education camps help to break myths and taboos related to health and our body, stoppage of alcohol and tobacco abuse, promotion of ORS in diarrhea etc among people. We also periodically publish small booklets on common diseases, basic laboratory investigations, healthcare in disaster etc.

070 HEGDE, B. M. (Chairman, state Health society Expert committee, Govt **of** Bihar Patna). WISDOM OF THE HUMAN BODY.

"You know what's wrong with scientific power? It's a form of inherited wealth." Michael Crichton.

Science is making models, mostly mathematical constructs. "The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct which, with the addition of certain verbal interpretations, describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work." This was first expressed by John von Neumann (1903-1957), an American mathematician and computer scientist born in Hungary. Medical science is no exception. The present model in medical science follows the linear mathematical formula. Unfortunately, the human body is a dynamic chaotic system that follows the non-linear mathematical rules of the new science of chaos. (1) That has been the fundamental mismatch between these two. No wonder that we are in this mess where most of our quick fixes based on the linear mathematical models do not seem to work well. Several audits have shown our interventions in poor light. Adverse drug reactions, dangerous interventions that result in more misery for the patient and the linear assumptions leading to wrong management of chronic diseases have defied our efforts at cure. (2)

Present human physiology:

Second curse has been the foundation of medical science based on two strong pillars, e.g. Mendalian genetics and Vesalius's anatomical divisions into organ based specialties. Mendalian inheritance based on nuclear DNAs is found wanting with the discovery of vital non-nuclear mitochondrial DNAs (mtDNA) which have the final say in the cellular function and evolution. (3) Darwin's hypothesis has also been found wanting in human evolution and physiology. (4) Our wrong policies of running after the disease (diagnosis) model and not wellness model is the greatest tragedy for mankind. It is economically sound policy to pursue wellness and try and keep the well healthy rather than go after the reductionist disease model where there is a disease called diagnosis. The end of the disease era is in sight. (5)

Human body also lives in sync with its environment. Health care should take the environment into serious consideration to be useful. The biggest blow to medical science has been ignoring the all powerful human mind from the diagnostic paradigm. In fact, most diseases originate in the mind and also get cured through the mind. The mind rules the body. (6) The mind resides in every human body cell at the sub-atomic level. This individual consciousness is a part of the universal consciousness where we are all interconnected. Each cell would want to merge with cells in other organisms as well. But for the immune system, we would have all become a large syncitium! (7)

New Holistic non-linear mathematical model of human physiology:

With this background it is easy to explain the real non-linear model of human physiology. The king pin in the human body's working is the individual cell which functions like a universe in itself, fully self contained. In fact, it took one and half billion years for the first nerve to appear in a Jelly fish and another half a billion years for the brain to appear. But the cell lived all along quite well without the nerves and the brain.

Each human cell could be compared to a super computer with its hard ware in the structures that we are taught in medical school and the soft ware, which runs the cell, in the ten thousand odd proteins in the cytoplasm, which form two distinct energy systems-high and low. Some of the note worthy proteins are the HSP 70 protein (heat shock protein), otherwise called SRP (stress relieving protein), Nitric oxide synthase protein and the VEGF 165 protein. (8)

The low energy system collects all the information from the environment and the electromagnetic energy from the Sun (Schumann rings around the globe) to transducer the energy to be passed on to the high energy system, which runs the mitochondria and other hard ware of the cell for us to live. The above three proteins are otherwise called the chaperon proteins as they do direct all actions inside the cell.

The cell, whether in the brain, heart, kidney or the liver is functionally the same although anatomically are different. Holistic non-linear science concentrates on the cell as the pivot around which the organism lives, gets unwell or dies! The inside of the cell does not work in a linear fashion. It works

more chaotically with a capacity to deviate from its "so called" normal function (as defined in the present paradigm) to have enough laxity under stress. Only when the healthy attractor in phase space falls far beyond the flexibility range does the cell function get closer to the static attractor of death from where it rarely bounces back to normalcy.

Majority of the deviations from the normal could be corrected by the body as the healthy chaotic attractor is a powerful force that attracts the cell function back to its original form. If, on the other hand, the cell function gets thrown too far into phase space closer to the static attractor no drug or intervention could get it back, though. (9) It was very prophetic that it was said that a physician could "cure rarely, comfort mostly, but console always."

New science of chaos and non-linearity:

The new paradigm, therefore, concentrates on the whole organism with the individual cell as its fulcrum. If the cells could do their job well, irrespective of the organ involved, we will have achieved success in that the organ and the organism start working normally. So it is time now to walk away from the organ based disease model to the sick cell syndrome which is both holistic and non-linear. In this universe no system is linear and regular, human physiology is no exception. Irregularity (chaos) is health and regularity (static state) is ill-health, death being the highest static state (9)

Because the system is lax there is flexibility in body physiology. Unlike what we are taught in the medical school the blood pressure can never be the same from one minute to another, so is the heart rate or, for that matter, any other parameter. One could study this healthy irregularity (healthy chaos) to see if the person is healthy, becoming unhealthy or is seriously ill by demonstrating the degree of laxity in the system. This goes very close to the Gaia theory originally formulated in the 1960s by the independent research scientist James Lovelock, as a consequence of his work for NASA on methods of detecting life on Mars. He initially published the *Gaia Hypothesis* in journal articles in the early 1970s followed by a popular 1979 book *Gaia: A new look at life on Earth.* (10)

Heart rate variability:

Study of heart rate variability (HRV) using modern computer models is a very accurate assessment of cardiac function. Our own work in the last three decades strongly points in that direction. (11) (Figures 1 through 4)

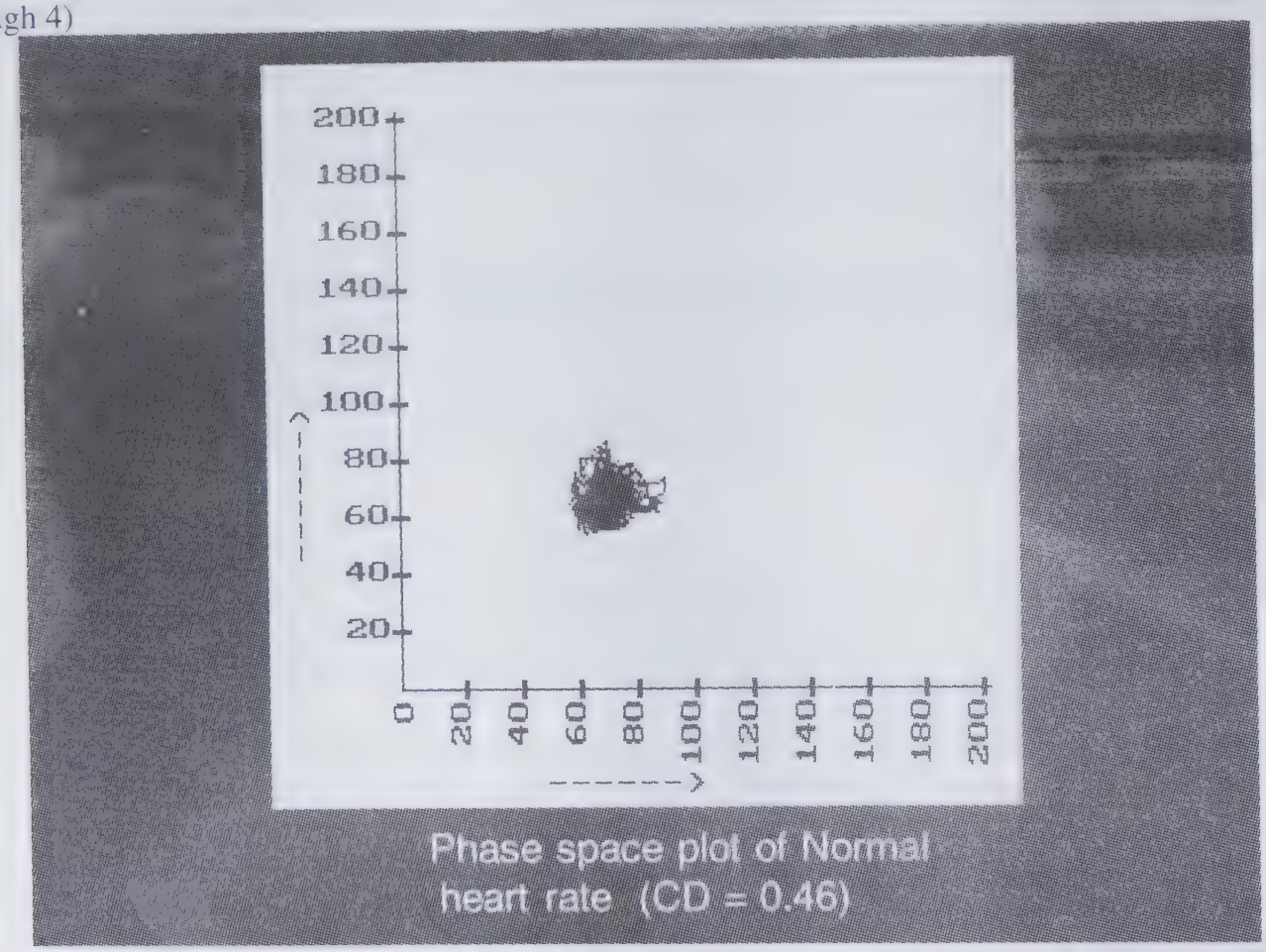

Figure 1. Two dimensional model of heart rate variability in a healthy adult.

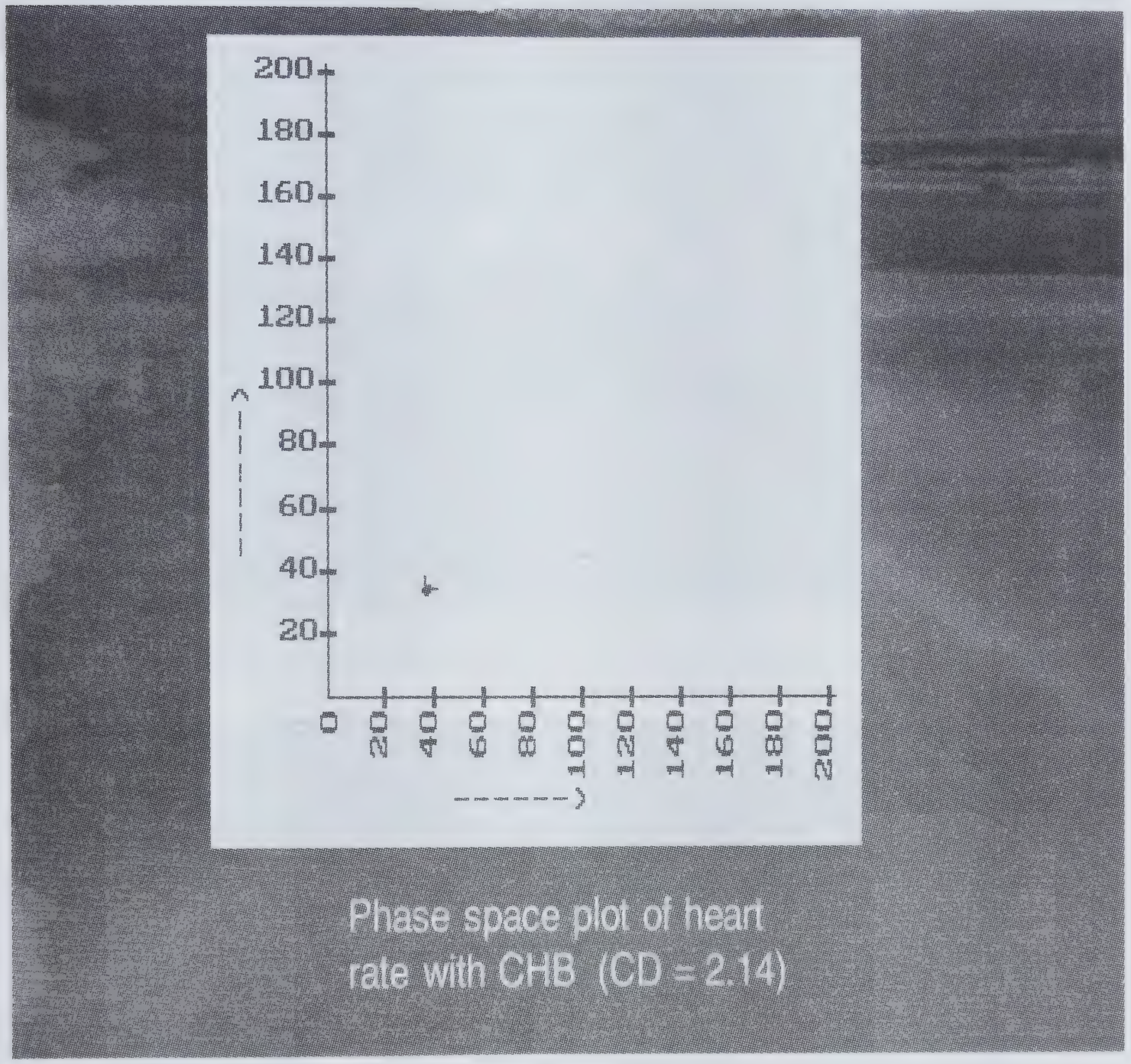

Figure 2. Two dimensional model of HRV in an advanced patient with ischaemic dilated cardiomyopathy.
Note that the heart rate variability seen healthy heart (fig. 1) is almost absent in the advanced disease state (Fig. 2). The second patient died a couple of hours after the tracing was taken.

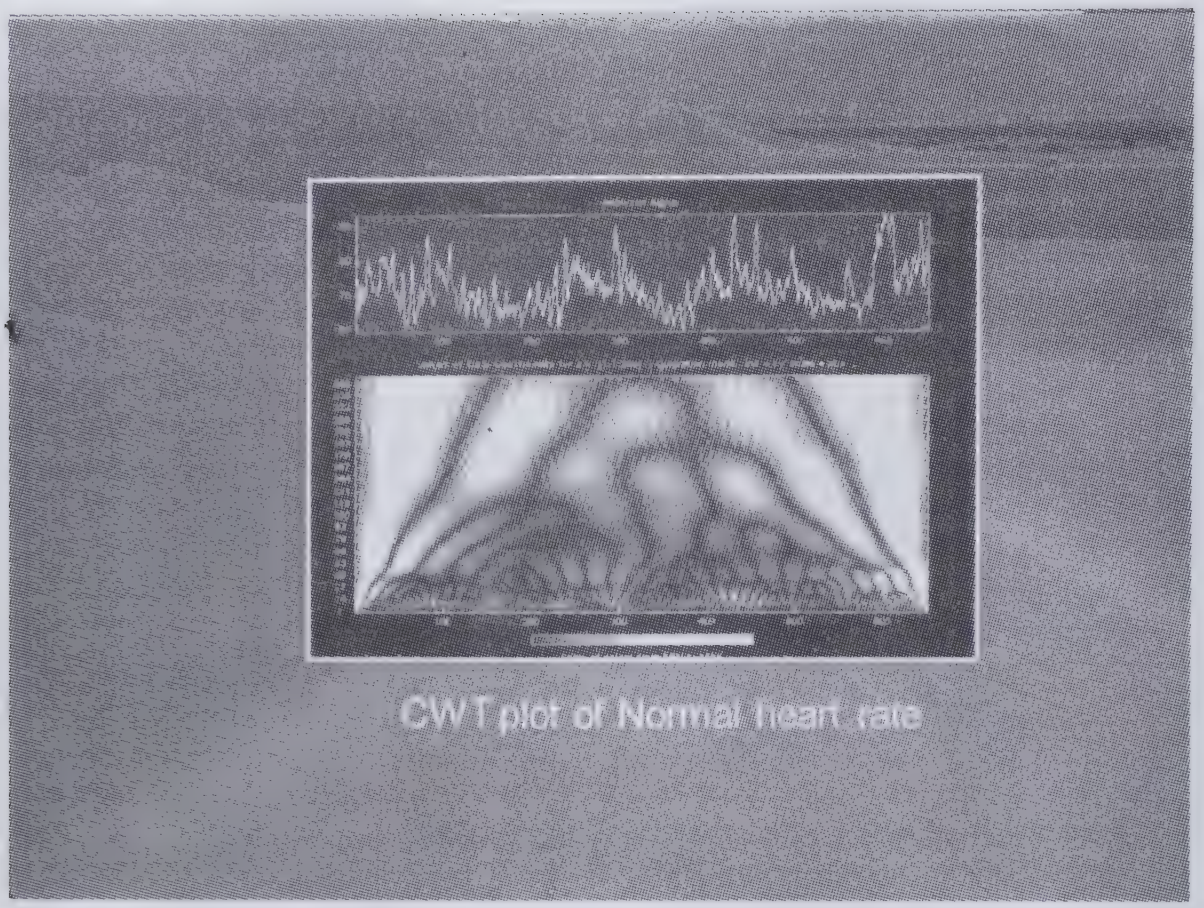

Figure 3. CWT pattern of a normal adult heart. Note the chaotic irregularity.

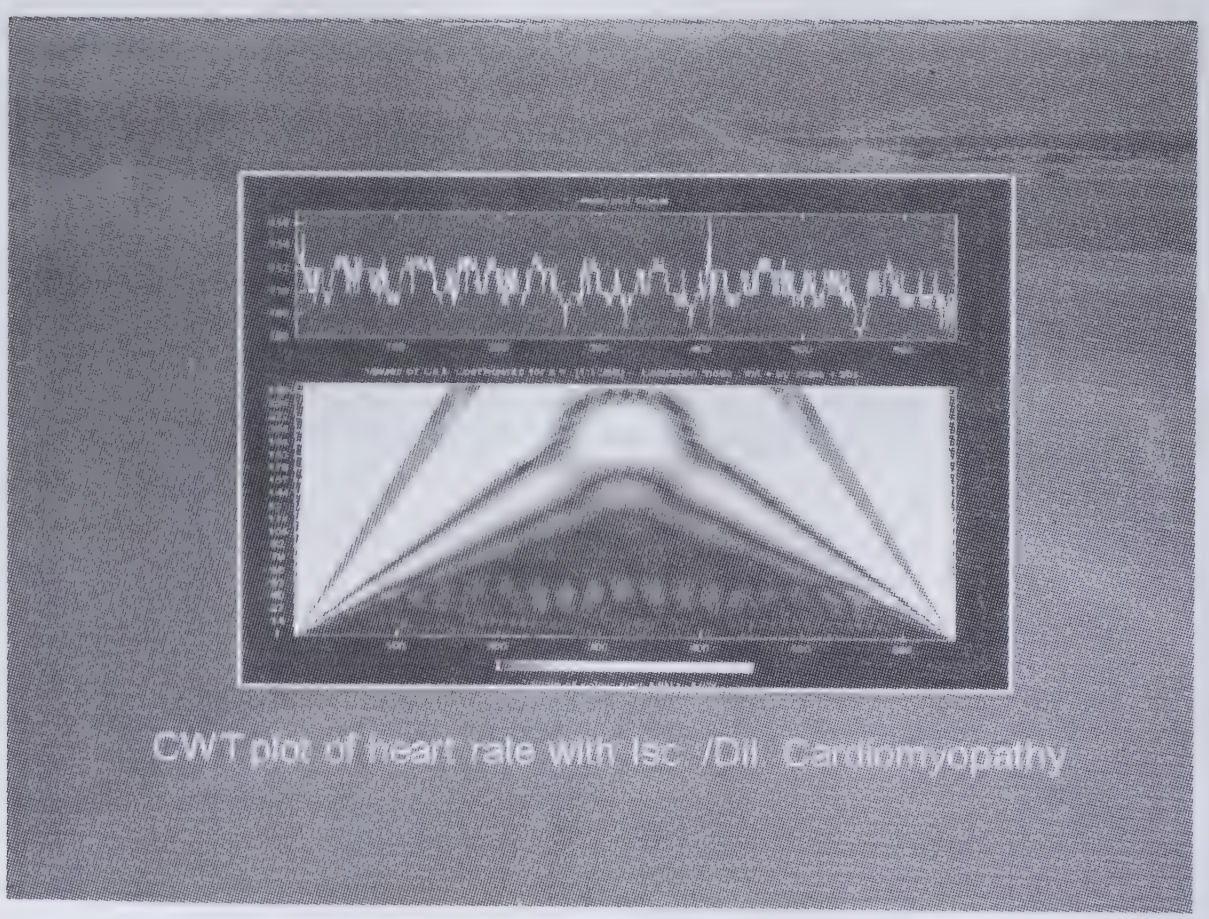

Figure 4. CWT pattern of advanced ischaemic dilated cardiomyopathy. Note the regularity.

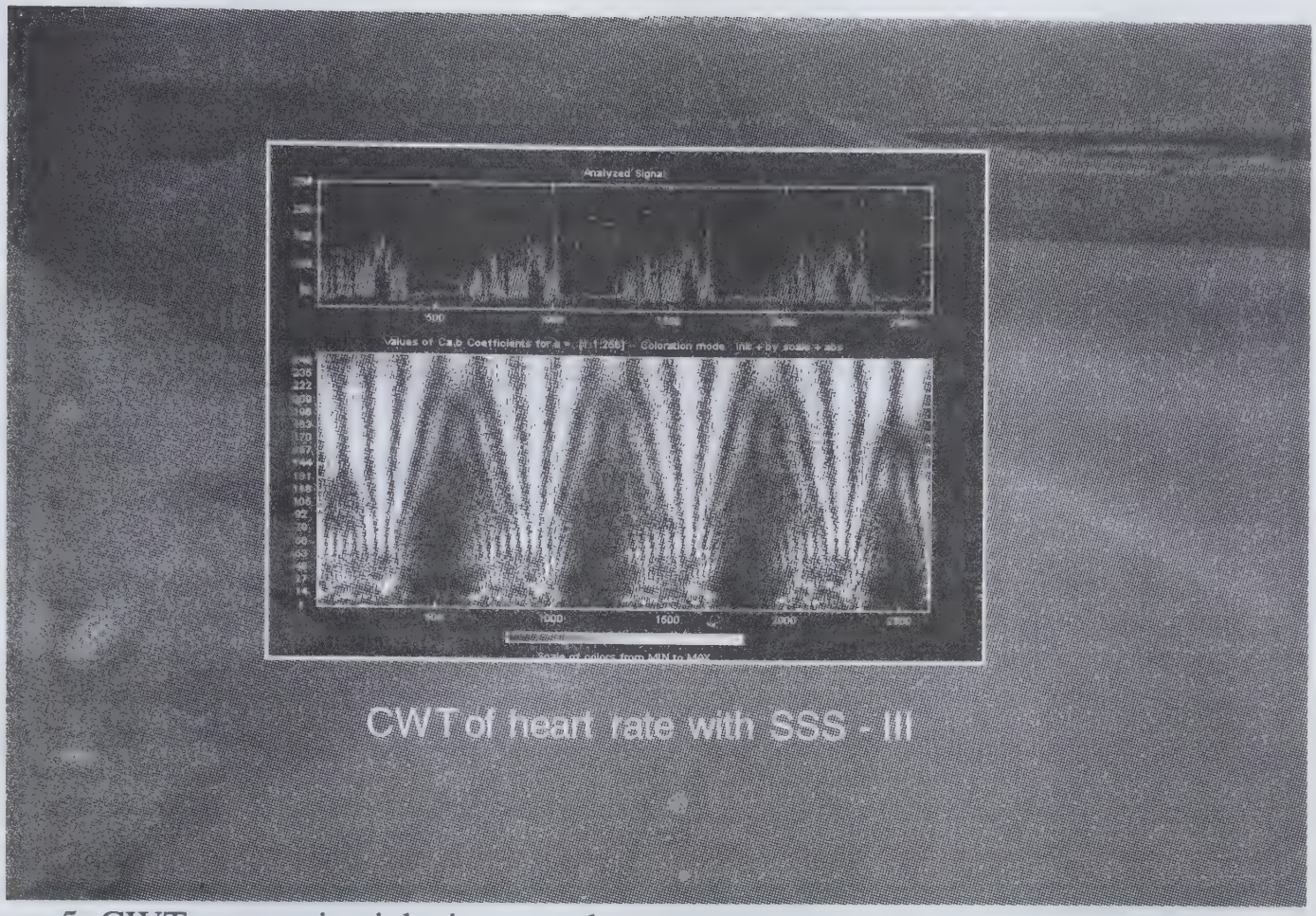

Figure 5. CWT pattern in sick sinus syndrome.

CWT plots could also assist in many tricky cardiac diagnostic problems as each disease pattern is pathagnomonic. (See the pattern of sick sinus syndrome in figure 5) Similar tell tale findings will reveal the diagnosis of some difficult arrhythmias e.g. supra-ventricular tachycardia with aberrant conduction down the Bundle of His mimicking ventricular tachycardia in the surface ECG tracings. The treatments of the two are diametrically opposite. The two have very distinct CWT patterns that could be recognized even by a junior medical student.

David Eddy, a brilliant Mathematics brain and a former professor of cardiac surgery at Stanford has come up with an excellent computer model of the non-linear virtual human physiology using more than ten thousand *differential equations. (12)* He has given a new direction to physiological research and also for newer approaches to management of illnesses. His model www.archimedesmodel.com could be viewed and used by any student interested in human physiology. If one uses that model and measures the outcomes of most of our present interventions in chronic diseases, we get to know how far outside the bull's eye that we have been aiming at with our reductionist logic. This would also explain why there are so many iatrogenic problems today.

Consequences of our present model on patient care:

The recent IOM audit in the US and as also the audits of doctors' strike in some countries in the past 25 years show that the medical establishment today with its hi-tech linear quick fixes has been the greatest bane of human health and life! (2, 13) Before it gets worse, we better wake up to the reality that doctors should assist the human body's wisdom in trying to correct itself under most, if not all, conditions where there is a deviation in normal body physiology. Occasionally we might have to resort to corrective surgery. Most of the chemical molecules in the western pharmaceuticals are known to damage the hard ware inside the cell rather than stimulate the soft ware. (3)

Recent POISE study did show how the use of metaprolol peri-operatively (to save more lives using our reductionist logic) has only resulted in significantly higher deaths in the metaprolol group. (14) Similarly a large retrospective audit on patients on ACE inhibitors who underwent major surgery showed that people taking ACE inhibitors had significantly higher unexplained deaths! (15) The recent BARI II study did show how coronary revascualrisation does not offer any special benefit either in death or disability over good medical care and change of mode of living as advocated way back in 1773 by Charles Scharsmidst in Vienna in his textbook of medicine. BARI II also showed how insulin supply in that

situation does not make much of a difference. (16)

In the holistic logic all these make sense. The autonomic nervous system is built in to protect us in times of stress, as for example in accidents and bleeding etc. Naturally, the autonomic nervous system could do a lot of good under those circumstances-redistribute circulations to the vital organs, produce vasoconstriction at the bleeding site, set in motion the clotting cascade to arrest bleeding and many other life saving tricks inside the system even without any external help under stress! Any surgery is very stressful to the organism. If we knock off the autonomic nervous system peri-operatively we are asking for trouble, indeed.

Sometimes unnecessary interventions could go against this natural protector, the autonomic system. Analysis of the per capita deaths in Falklands War for the British compared to the Vietnam War where the Americans had a five star hi-tech hospital almost next door to the war theatre. Immediate resuscitation with blood transfusion and warming with blankets does interfere with nature's protective mechanism. The British did not have any such luxury in Falklands. Some of the grievously hurt soldiers were on the snow clad ground for up to 24 hours before being taken all the way to England for treatment. Despite that the per capita deaths in those grievously injured were almost identical-one in 46 in Vietnam and one in 45 in Falklands. These are just some of the examples of the hazards of over intervention without trying to understand the wisdom of the human body. (17)

Even in emergency treatment, which is being brandied as our greatest triumph, there are large gaps in our knowledge, thanks to our reductionist logic. While there is a "dry theory" of fluid restoration in an emergency, we opted for the "wet theory" which advocates drop per drop replacement of fluid loss. (18, 19) This ignores the human body's capacity for auto-transfusion and auto-infusion when needed. If we ignore that and infuse fluids according to our calculations, deaths would naturally be more (Vietnam for example). Nil by mouth and total parenteral nutrition depletes the gut wall of its normal environment. Gut wall being the head quarters of the immune system, the empty gut with altered milieu could suffer in the intensive therapy units. That could even push patients into DIC and many other complications. (20, 21)

I wonder if our scientific knowledge in the area of fluid and electrolyte balance is adequate in our reductionist logic. Take the example of potassium. While we calculate our potassium deficit based on the extracellular potassium, there is a lot of potassium in the cellular arena that could balance the need. Even biochemists have advised not to replace the entire deficit according to the King's formula. If the formula is not accurate why then follow it at all? Potassium excess or deficit could both be dangerous in critical emergencies. Human body's enormous capacity for transmutations is also not understood by us. Biological transmutations have come to stay. (22) Similar is the uncertainty about crystalloid-colloid replacement debate. The last word is yet to be written.

New management paradigm:

Let us look at what happens in the new paradigm where we assist the body's wisdom in managing deviations from the normal physiology. Some examples are given hereunder. While the normal electrocardiogram is only an artifact of the electrical activity in the heart, the new HRV pattern that we developed over the last three decades gives us a better assessment of the cardiac patho-physiology. The two dimensional and the later CWT (continuous wave transform) pattern using the non-linear analysis of the Holter tracings give us a lot more information. Many a time the patterns are diagnostic of even difficult arrhythmias. (11)

The electromagnetic energy device (8) mentioned above has given significant results in as varied conditions as myocardial infarction, strokes, wound healing, fracture healing, diabetic ulcers, hitherto untreatable degenerative diseases of the brain, bed sores, angina, and many hitherto difficult to manage inflammations.

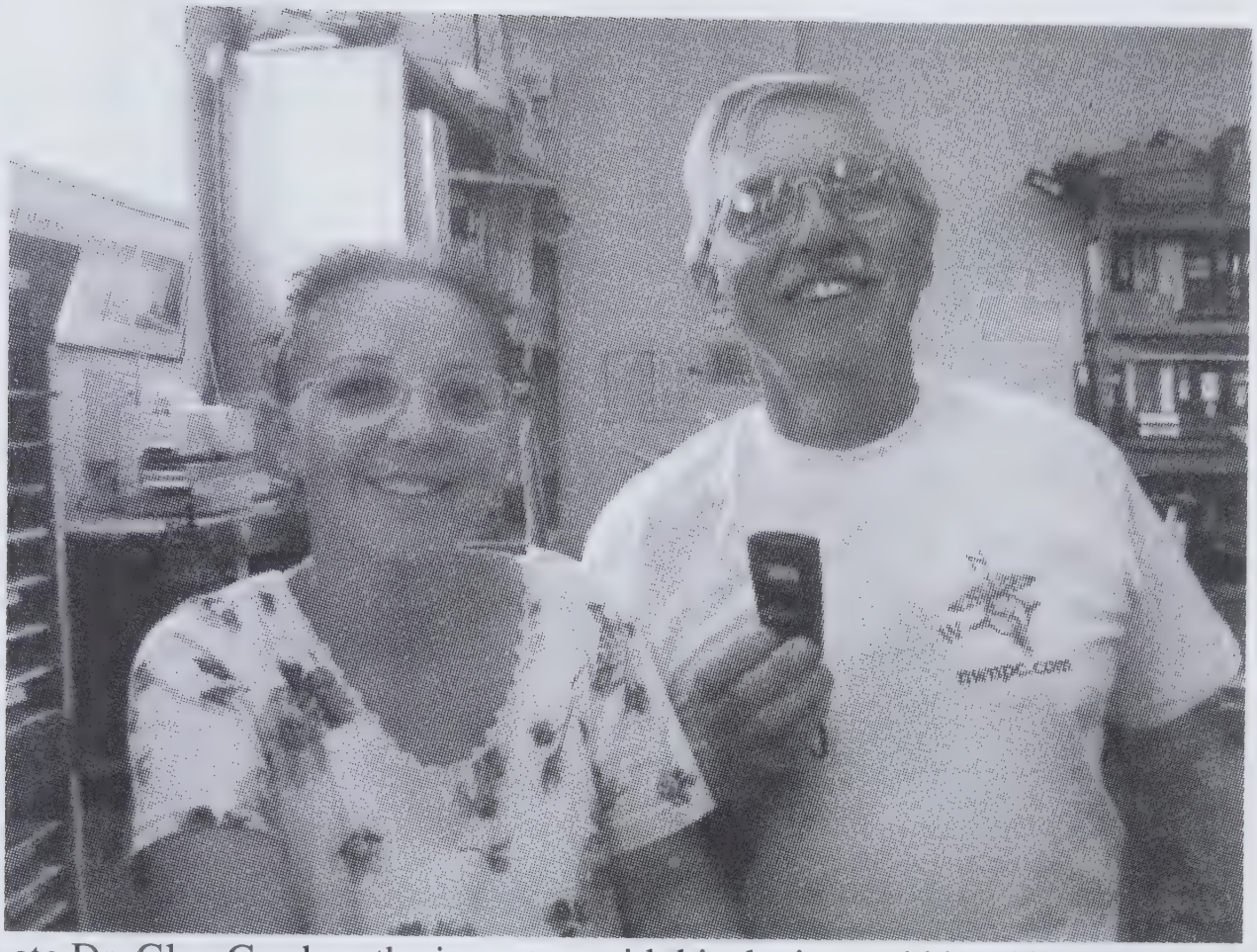

Fig. 6 Late Dr. Glen Gordon, the inventor, with his device and his wife.

This could easily be explained by the fact that when an ischemic or dying cell gets its adequate energy supply through the EM Probe, the cell could get rejuvenated setting in motion the repair process in all the above mentioned situations. We have a long way to go, very long way indeed but, the beginning is so encouraging that this new technique looks very, very promising indeed! (23)

The future:

More research is urgently needed to go further in this field. Unfortunately, no research dollars are pouring in here because it does not bring in rewards like our reductionist drugs and interventions. I am reminded of a paper I wrote years ago on the *unconventional wisdom in medicine* which was rejected for five years by many journals to be eventually published, with my head and shoulders photo, by the Bulletin of the Royal College of Physicians and Surgeons of Glasgow. (24) (25) When I re-read that now I am reminded of what Robert Browning said when asked to re-read one of his poems thus: "When I wrote the poem only Robert Browning and God knew what it was, today I think only God knows." I get the same feeling today as I was only speculating those days but have made some progress now. However, God only knows where we are headed. Hope better days will dawn on the medical scientific community to visualize a brighter future writ large on the distant horizon for the benefit of the suffering humanity.

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071 HEGDE, B. M. (Manjunath Pais Hills, Bejai Mangalore 575004). NEED BASED MEDICAL EDUCATION.

This is an attempt to look at our present day medical education from within, after nearly five decades of, I hope, fecund involvement. Modern medical education in India goes back to the year 1857, when the East India Company started three medical colleges in Madras, Bombay, and Calcutta. The initial syllabus was brought from the London University. It has, of course, changed a bit here and there, but there has never been an attempt to really do some introspection for nearly one-century and a half. There has never been an attempt to see if our hoary past, with its wonderful medical knowledge, could, at least, be amalgamated with the western thoughts brought from outside, with benefit to the suffering humanity.

Most of us inside the system have a holier-than-thou attitude towards anything Indian that has not been certified to be scientific by the West. I think time has come now to think of all that, as the West itself is looking to the East for inspiration in this field with the top heavy, hi-tech western medicine having

become prohibitively expensive. The London Royal College of Physicians recently brought out a manual, following a symposium on *The Science of Alternative Medicine,* highlighting the positive aspects of the latter and also bringing out a lot of good scientific material in them. It is time now for us to take a fresh look.

What is wrong with the present system?

On the surface everything looks good. Many would want to know that if it was good enough for us why not continue it for the next generation. How good is good? Modern hi-tech medicine, sold all over as very scientific has a very shaky foundation. David Eddy, a former associate professor of cardiovascular surgery at the Stanford, after very extensive research and doing his PhD in mathematics, wrote that 85% of what doctors do is based on very soft data, while only 15% is based on hard unequivocal data. He has now invented a new computer model ARCHIMEDES that shows most of our interventions in very poor light.

The recent UNIDO report showed that about 80% of the world's population today does not have the benefit of modern medicine. Many studies have very clearly shown that the most important risk factor for all diseases, from common cold to cancer, is poverty. Poverty and ignorance begin to have their ill effects on the future man right from the first trimester of pregnancy inside his mother's womb and bothers him chasing him to the tomb! Studies in the West have shown that whereas the diseases are in plenty in the far-flung villages, surplus of doctors are in the cities and metropolises. This *inverse-care law*, propounded by a family doctor, Tudor Edward Hart, working in a Welsh mining village, speaks volumes about what happens in the third world countries.

The art of medicine, that which makes the patient's day, is not being taught enough in the medical schools. Even when passing remarks are made by some teachers about the art of medicine, most of it gets drowned in the sea of awe-inspiring technology. There is a lot we could do in this field, as shown very well by an Oxford professor, David Weatherall, in his book *The Science of Medicine and its Quiet Art,* and by Shervin B. Nuland, Stanford professor of clinical surgery, in his book *Wisdom of the Body.* This has been proved by a scientific study by a group of professors of medicine in England published in the *BMJ.* Professor Calnan's book *Talking with Patients* brings out the anguish of a thinking teacher at the Hammersmith hospital, London. Too much of technology and teaching subtleties to undergraduates were shown to be counter- productive in a study by three generations of teachers in the department of cardiology at the St. Andrews University, Dundee.

The student gets lost in memorizing data for the sake of the examination and thus loses sight of the woods while counting the trees. Bereavement is an integral part of a doctor's life! Very little input is given in this direction to students to cope with it. Memorizing the subject has another dangerous consequence in that the student just before the examination, and if he passes the examination for ever after, deludes himself with the idea that he *knows everything that is to be known.* This feeling of *"knowing"* is suicidal in this field. One should aim at making the student realize genuinely that he *does not know!* That is where curiosity starts and wisdom begins. Another very important reason why medical education has become irrelevant to the present day needs is the craze for trying to do good to the *apparently healthy* in society in the name of *health screening and predicting the unpredictable.*

Predicting the future of any organism in this dynamic universe needs the knowledge of the *total initial state* of the organism, which is impossible today since we have no clue about the genotype of man and his consciousness! In addition, the linear thinking that if one were to change the *initial states from abnormal to normal there is no guarantee that this change holds good as time* evolves. Time evolution in a dynamic system does not follow this rule. Long term studies have shown the futility of this kind of exercise. Doctors have been *predicting the unpredictable* was the judgement of a physicist, professor Firth, in his enlightening article in the *BMJ* in 1991.

What could be done to rectify this?

Content and Methodology: -

The syllabus is already overburdened. It can not and should not be expanded; instead it could be profitably cut short, without affecting the quality-nay even enhancing the quality of education. Problem-based learning, where the student and the tutor are both curious to learn, would be a better method. More time should be given to the students to think for themselves, in place of all the didactic teaching of facts. Facts keep changing everyday, what with the new information pouring in at a phenomenal pace of seven per cent per month. *The correct method of obtaining the data from many sources today is to be taught in place of teaching facts.*

Didactic lectures could be cut to the bare minimum, replaced by small group tutorials. Studies have shown that an unprepared mind absorbs less than five per cent of what is told in a lecture class. Clinical clerkships must take more of the student's time. There again the ritualistic bedside clinics should give place to collective effort between the teacher and the taught to arrive at the diagnosis and management strategies for every patient under their charge. Then and then only does the student realize the most important lesson in medicine that diagnoses and management are basically full of *uncertainty.* The gray zone in medicine is expanding every day and the student should be aware of that as much as the teacher.

Medical education should be a collective effort at learning between the two parties, the teacher and the taught. The conventional *teaching by humiliation* should give place to learning with pleasure with a footing of equality. On the bedside the student learns by observing the teacher, in all its ramifications, viz. manners, ready wit, compassion, understanding, human dignity, patient leeway, frustrations, anxieties, and what have you. This would give the student the courage to keep learning. To know that the *emperor also could be without his robes* is a very good stimulus to learn.

Specialists Vs Generalists:

There was a craze for specialization in the West for more than two decades now. There were so many specialties and subspecialties that they have now realized the bad effects of these both on the recipient, the patient, and also on the system. This kind of fragmentation is doomed to fail as per the 1st Law of Thermodynamics! Medical specialties grew directly proportionate to the growth of technology. The result is that technology has become top heavy and the hospitals have become prohibitively expensive even for the middle class Americans.

The University of Minneapolis has started the system of having three major specialties: general surgery, general medicine and midwifery. Only when there is a definite indication for any type of intervention does the patient get referred to the particular specialist. Similar trend is coming to the UK also. Of course, we Indians believe in the dictum that we have to make the mistakes ourselves before we learn from them. We are wise enough not to learn from other's mistakes. We are where Americans were twenty years ago, starting more and more specialties and corporate hospitals.

A large country like ours, where more than 80% of patients are spread over the 5,75,000 odd villages, we would have to, per force, have more generalists. In addition, our present day medical training for a graduate is not conducive to send him to a village to manage alone. He would be a fish out of water there, as the ground realities in the community incidence of illnesses is not represented in the teaching hospitals. This is one of the main reasons why doctors do not want to go to the village. New doctors are not comfortable with their clinical abilities sans the hi-tech that they are used to in their medical school hospitals. Our graduates are good for working as junior doctors in larger corporate hospitals to order all the tests for every one who comes there for the boss to review or to work in junior posts abroad. Left alone in a village he would be helpless.

Evaluation:-

This is the real pain in the neck for both teachers and students alike. I know of no fool proof method of evaluation. The present system that we follow, which has been followed since the beginning of medical education in India, is far from satisfactory. Even though the best is yet to be thought off we could try and make it more effective. The end term, one time examination should be replaced by continuous on the job evaluation. This could be split into teacher evaluation and peer evaluation. The latter could bring

out the weaknesses and strengths of a candidate much more candidly. The teacher evaluation should be a long drawn observation in place of the short, anxiety generating, incomplete assessment.

The debate about the type of theory examination is a never-ending one. The West went into the multiple choice objective theory tests, only to go back now to the time-tested essay type examination. However, both of them test the memory power of the examinee and not his total ability. In their place a novel creative type of theory examination could be held. The student is posed a real life problem and is given enough time to write a critical answer on the lines of his future work outside. A critical appraisal of the problem should be able to give the candidate the capacity to learn the communication skills also in later life.

Practical and clinical examinations should mimic the real life situation. They should aim to assess the candidate's ability to listen to his patient, his compassion and human understanding, his knowledge of the clinical methods of eliciting the signs of disease, his interpersonal relations, his ability to get on with colleagues, his temperament as a doctor, and his mastery of the diagnostic skills and management strategies. Viva-Voce examination is an opportunity to check the student's thinking capacity, instead of once again assessing his memory recall. This could be utilized to find out what kind of a doctor he would make in real life, his interest in furthering his skills and knowledge, his capacity to look at the same thing from different angles and also to fathom his reasoning power.

Examiners should have also a check on them. All the markings should be in the *close-marking method.* The positive and negative aspects of the student's abilities should be noted down for the future guidance of the candidate should s/he fail to make the grade. The examiners' performance should be computerized to assess them as examiners. Erring people should be blacklisted and their names sent to all the examining bodies with valid explanations. They could be reassessed after the lapse of a particular number of years!

Beyond the Four Walls of the Class Room:-

Doctoring needs more skills than all that is written above. There are important areas not covered by the conventional teaching methods. One area that needs wider knowledge of human affairs is the capacity of the doctor to handle the only certain thing in life that is death. One of the questions asked is "*why*" did a patient get a particular disease or why did he die? These two questions could never be answered in biology. One needs to know a bit of teleology and also philosophy. Positive sciences answer the question "how" or "how much", but not the question "why." One needs special skills of compassion and understanding to manage bereavement and separation.

The bane of modern medicine today is its cost. Every doctor must have an exposure to pharmaco-economics. It is one thing to read a book and write the medicine or order an operation, but the crux of the matter is if the recipient is able to afford that and if not what are the alternatives. That leaves the much-harried patient in a worse state. The mind of man is known to be the most important part of the whole gamut of health and disease and the modern doctor should be able to unravel the depths of human mind, with a reasonable knowledge of human psychology, local customs, taboo, fears, anxieties and even superstitious beliefs. An assessment of the patient's surroundings, his worries, his anxieties, his near and dear ones, and his social ties would all have to be taken care of in some special situations.

Knowledge advances by refuting false dogmas. Genuine research demands that doctors keep an open mind on all aspects of their learning and try and get the false dogmas demolished to the extent possible. This requires the capacity to keep meticulous records of all our dealings with patients sincerely and honestly. Documentation should be taught to students from day one in their routine work as well. Research is not repeating others' work in your laboratory. Clinical medical research is "having a question on the bedside and trying to go as far away from the bed as one could to get an answer." We urgently need a uniform national standard for our postgraduate degrees to be recognized all over the world.

In short, medical education is an education for life. The right kind of education would bring out the best in every doctor who becomes patient friendly and would be able to most good to most people most of the time. He is ideally *one who knows not but, knows he knows not. May his tribe increase!*

072 MUKHERJEE, KRISHNENDU (MBBS MS FRCS ed consultant Surgeon 26, Beadon Street, **Kolkata- 700006**). THE FUTURE OF MEDICAL EDUCATION-VISION FOR A BETTER TOMARROW

Medical education in India has been largely modeled on the British systems of yester years. Despite some changes in the curriculum and post graduate training programmes it has remained by and large on the same plank. Few basic premises need to be defined before any futuristic analysis is attempted. Medical education is certainly not synonymous with health education but is a self-contained area which has to have the fundamentals embedded in the relevant sciences and other aspects of health education need to be complementary to medical education. Secondly, while healthcare delivery systems has to be tailored to the society in question, medical education however has little to do with social differences with some exceptions of epidemiological variations. Basic sciences of medicine and core knowledge and competence required in the applied specialties are the same throughout the world. Thirdly, indigenous or alternate systems of medicine are not only of questionable value, their incorporation in "medicine" is not possible. There may be more than one answer to a particular clinical problem but the scientific approach to the understanding of health and disease cannot be duplicated. Provided indigenous systems are subjected to similar scientific avenues, they are automatically incorporated in "medicine"; there is no "western" or "eastern" medicine, like there is no "alternative" chemistry or geography.

This paper will draw on experiences starting from similarities of Flexner report (1910) about quality of medicine education, Bayne-Jones report(1958) about doctor-patient ratio, WHO projection of projected shortfall in health workforce and current problems and perceptions of medical students and graduates – part of which is based on an original author's study. It will also deal with preemptive solutions of problems expected in future, possible solutions of preserving a welfare state approach in education even when market economy gets a free run and consider changes of and modernization of those aspects of medical education and training which need to be urgently addressed.

Ambit of discussion and suggestion will therefore include – introduction of EQ/IQ scores and communication skills and aspects of sociology, introduction of simulator based learning, working towards "joint quality council" (by drawing upon MCI, National Board and Professional Specialty Associations) who will author and edit exhaustive syllabi and publish universally acceptable textbooks for the country, changing the post graduate entrance models and bringing back obligatory house-staffship, extending house staff-ship to district hospitals and attaching CME incentive points for rural works, generating capital by health education bonds, abolishing tax benefits for "research" by private organizations and imposing educational demands on private sectors etc.

This paper appreciates that major changes cannot be brought forth overnight. However relatively simple modifications can make an important beginning.

073 PUSHPANGADAN, P. And V. GEORGE (Amity Institute for Herbal and Biotech Products Development**Amity Institute of Phytochemistry and Phytomedicine 3, Ravi Nagar, Ambalamukku, Peroorkada **P.O, Thiruvananthapuram – 695 005, Kerala).** THE ROLE OF TRADITIONAL KNOWLEDGE IN PRIMARY HEALTCARE AND ENVIROMENTAL EDUCATION.

Traditional knowledge is a community based functional knowledge system developed, preserved and refined by generations of people through continuous interaction, observation and experimentation with their surrounding environment. It is a dynamic knowledge system everchanging, adapting, expanding and adjusting to the local situations and it has close links with the culture, civilization and religious practices of the communities. It covers all spheres of human activity such as art, architecture, agriculture, literature, education, environment and all other human vocations. Man depended entirely on nature's bounties to fulfill all his demands, physical, material, aesthetic and spiritual. This close dependence on natural

resources for survival enabled him to live in harmony with nature, making use of the resources just to meet his immediate requirement. Also, over the years, man learnt to cultivate the crops he wanted, he even experimented with crop improvement, evolved new varieties, discovered better genetic resources, learned the art of conservation and sustainable utilization

of important plant varieties. Apart from edible plants, he also experimented with plants that could provide him with drugs to treat his ailments, oils for cooking as well as to burn in the lamps, fibres that could provide him with clothes, spices that could add flavour to his food, aroma that could stimulate his senses, dyes that could add colours to his clothes, pigments with which he could paint and a host of other products. Until the beginning of the 18th century, man had been extremely careful to maintain nature's balance, recognizing the rights of every living thing to thrive, multiply and share from natures bounties.

This rich knowledge system that has been developed over the millennia has come down to us and is fast disappearing from our generation as we have turned away from our traditional life style. Attempts are being made at Government and NGO levels to document and conserve this knowledge system for posterity. In this paper the role of traditional knowledge in health care and environmental education will be discussed.

074 SINGH, M.RAM; KAZMI, Q.A.; S. ISMATH And G. SOFI (P.G Scholar, Lecturer, Dept. of Iimul Quabalat wa Amraz Niswan, Dept. of Iimul Advia, Kottigepalya, NIUM, **Bangalore**). EFFECT OF THE INCLUSION OF SCIENCE AND TECHNOLOGY ON CURRICULUM REVIEW OF AYUREVEDA AND UNANI SYSTEM OF MEDICINE.

The Study appraised the effect of science and technology on teaching of traditional medicine; it also explored the effect in terms of attitude towards the inclusion of scientific and technical innovation in these system.

the syllabi and the teaching methodology as described in ancient text and the new curriculum of the University of Karnataka revised from time to time were analyzed by devising scoring system for the analysis of the scores. The scoring method was devised in consultation with senior faculty of National institute of Unani Medicine (NIUM) and rated by the experts from allied fields of science and education of university of Bangalore. The effect of the inclusion of newer concepts was evaluated by framing attitude questionnaire for curriculum satisfaction.

The Results of the study were conflicting. The inclusion of science and technology although gave impacts to research and evidence based medicine but the attitude of the personal of the traditional system of medicine was in their system was average towards inclusion of science and technology. The reason of such attitude will be discussed in the second Peoples Education Congress in Mumbai.

The study showed debatable trends for inclusion of science and technology in Ayurveda and Unani system of Medicine.

075 SATYA, SIVARAMAN (482, Mandkini Enclave Alakananka**, New Delhi).** INITIVATIVE FOR A HEALTHY INDIA.

The 'Initiative for a Healthy India', launched in Jharkhand earlier this year seeks to train youth belonging to social and political organisations working among low-income groups as community health workers.

The idea is to create a group of committed youth who can enhance their medical and health-related skills and make a direct intervention in poor, rural or tribal communities to help solve problems related to health. Their approach to public health will be holistic and take into account the social, economic and cultural factors that determine the health status of ordinary citizens in our country.

The first batch of ten youth from the United Milli Forum in Jharkhand have already undergone training provided by the Shramjibi Swasthya Udyog in Calcutta and are ready to work in the field. Fresh

batches of 10 to 15 trainees will be produced every two months under this program.

Efforts are underway to mobilize youth organisations in Bihar also to join this initiative for training community health workers and taking forward public health issues through a combination of direct medical service and political mobilization around basic social and economic rights.

076 SANKARARAPANDIAN, V. ; JOHN SM; PLAKKAL, A.; DAVID KV and ABHARAM S. AND BHATTACHARJI, S. (Assistant Professor low cost effective care unit chiristaian Medical College, **Vellore.**). FAMILY MEDICINE TRAINING FOR UNDERGREADUATE MEDICAL STUDENTS AT THE CHRISTIAN MEDIACAL COLLEGE, VELLORE.

In Christian Medical College, Vellore, which is one of the premier medical institutions in India, most of the clinical training for undergraduate medical students occurs at the tertiary care hospital. Undergraduate students are exposed mostly to the fragmented health care of medical problems seen at a tertiary level hospital and have insufficient exposure to common medical problems and comprehensive medical care. The family medicine posting was designed to address this need.

At the end of the posting the students are expected to:

1. Describe with understanding the concept of family medicine and its role in health care.
2. List and discuss the management of common health problems in family practice.
3. Apply consultation skills in doctor-patient relationships and understand patient perspectives.
4. Explain how a referral system works between primary, secondary and tertiary care.

The posting is divided into two phases. During the first posting at the beginning of the first clinical year, students observe the working of a family practice unit.

During the second clinical year, students observe patient care, workup and discuss patients with common health problems in addition to lecture/discussions. Under supervision they also perform common procedures in the out-patient area. They maintained the log of in-patients they examined.

Consultation skills based on the Calgary-Cambridge Model are taught through role-plays and discussions.

Students make home visits and interview patients who were referred to the tertiary care centre and are subsequently being followed up by the family practice unit.

Their knowledge and skills acquired in the posting are assessed by an Objective Structured Clinical Examination. Attitudes are assessed by written feedback and debriefing discussions. The posting is also evaluated by the students.

38 students participated in this posting in 2007. The mean score of the students in the OSCE was 25.76 out of 50 marks. Students' feedback revealed that they learnt: that listening to patient's perspectives in a consultation improves patient satisfaction; that socioeconomic factors play an important role in health and health care; the importance of good history and clinical examination in the provision of cost effective health care.

To our knowledge, CMC is the first medical college to introduce a family practice posting for undergraduate students in India. This short posting helped students to learn consultation skills and patient centeredness. Students could learn about only few common health problems because of the short duration of the posting. Role-plays and home visits followed by discussions were found to be very useful teaching-learning methods in medical education.

We suggest that the Medical Council of India includes family medicine posting in the undergraduate curriculum. We also recommend increasing the duration of this posting to one week in first clinical year and two weeks in second clinical year.

077 SEN, INDRANIL (R.G.Kar Medical College, Kolkata). MEDICAL EDUCATION IN INDIAN- A HISTORICAL OVERVIEW.

A simple truth is often overlooked that the Medical Education is part and parcel of the prevailing Medical and Health Care delivery system of any country. India is no exception to this rule. From time immemorial, treatment of the patient itself was the only method of imparting medical knowledge to a young learner. As far as the institutionalization of medical education is concerned, it was Taxilla where the first medical institution in India was known to function under the auspices of Atreya Punarvasu in c. 5^{th} century BC. However one should not assume that the 'institution' was anyway comparable to one in the modern sense. In fact, medical teaching in ancient India was centered around eminent medical personalities and the 'Gurukul' system, rather than the lecture theatres and the laboratories of the institutions established by the state.

With the introduction (Intrusion!) of the European medical system in India in the later part of the 18^{th} century, the concept of medical education changed. Gradually, the State-controlled institutionalization of medical education flourished and we have reached the present state of affairs in this field. In the independent India, certain superficial changes did take place as far as the standardization of the UG and PG curriculum is concerned under the control of Medical Council of India, but the model of medical education and the teaching-learning methods largely remain a replica of those practiced in the western world. In this connection, one must note that the introduction of 'Ayush' is an important step taken by the Government of India in the right direction but at the same time, the teaching-learning methods of this system must be in conformity with the original tradition and not in the line of the western methods, as the 'Health care' and 'Medical education' are mutually interdependent in these systems.

There is a prevalent concept among a large number of medical people that the indigenous medical systems do not conform to the concepts of 'Science' in the western sense and therefore they must be viewed with suspicion. It is not known that how many of them have really endeavored to delve into the background philosophical concepts of 'Science' as such, because in that case, they would have discovered that the basic idea of appropriating the fundamental concept of the biological sciences, the 'Life', with those of the material sciences in terms of chemistry and physics are being seriously questioned by a large group of leading research workers all over the world. Indigenous methods of 'Meditation' and 'Pranayama' are being successfully employed in the medical world as standard therapies in treating patients.

Isn't it better to doubt the efficacy of one's tool when it fails to perform, than to doubt the worth of the job itself?

In the present paper, the author has deliberately refrained from merely repeating the chronologically recorded set of events that took place in the field of medical education in India but tried to emphasize the socio-political, economic and cultural background of such events with an idea to look into the future necessity of designing the 'Medical education' in our country that will serve the millions living in the remotest corners of this vast country. After all, 'Health' of a country can not be super-imposed from outside, it should emerge from within the grass root level and the responsibility of the planners is to carefully study the needs of the people rather than import a fantastic program from abroad.

One can remember Nietzsche with a mild modification that- 'Tell me what sort of 'Health' you need, I shall tell you what sort of 'Education' you should give.'

078 VYAS, RASHMI; JACOB MOLLY; FAITH MINNIE ; BINA ISAAC And RABI SUGANTHY (Departments of Physiology, IDTRC, Medicine Christian Medical College, **Vellore-632002**). FELLOWSHIP IN SECODNARY HOSPITAL MEDICINE: A MODEL OF TRAINING FOR MBBS GRADUATES

Background:

Christian Medical College (CMC) Vellore, India is a tertiary care hospital. It has a countrywide network of over 200 secondary hospitals that are located in rural and underserved areas and are important providers of hospital-based care. CMC graduates, following graduation have a service obligation for a period of two years at these hospitals. The graduates are not well equipped to practice in the smaller hospitals and face many challenges such as the type of cases they have to treat, no access to academic resources and face academic isolation. This results in doctor stress and burn out. Thus CMC has designed a curriculum, Fellowship in Secondary Hospital Medicine (FSHM), to help prepare the graduates to practice effectively in smaller hospitals.

Methods:

FSHM was planned and designed as a one-year distance course by CMC and Secondary Hospital faculty with the objectives of providing the knowledge skills and attitudes to the participants to practice at secondary hospitals, providing improvement in service provision and promoting networking. The FSHM course incorporated the following:

a) Eighteen paper based distance-learning modules, which were developed by the CMC and Secondary Hospital faculty. The modules were based on the Open University, UK model including relevant topics in Medicine, Surgery, Obstetrics and Gynecology, Pediatrics, Anesthesia, Ophthalmology, ENT, Orthopedics.
b) Three contact courses at CMC (Total 2 1/2 weeks) which focused on developing clinical and procedural skills
c) Project work towards addressing a local health issue mentored by CMC faculty.

The graduates were assessed based on a combination of formative assessment such as feedback for distance learning activities, project proposals; and summative assessment such as distance course tutor marked assignment, final exam consisting of multiple choice questions and objective structured clinical examination, and project presentation. Evaluation of the FSHM program was done using focus group and written feedback form students and faculty.

Results:

The FSHM course was implemented in the year 2007. Thirteen recent graduates from CMC were selected and 11 completed the course. In the year 2008, 17 recent CMC graduates were selected and completed the course. Currently, in the year 2009, 35 FSHM participants are doing the course out of which 8 are graduates from outside CMC Vellore and working in secondary hospital.

The mean scores in tutor marked assignments, theory, practical examination and project assessment were 32.09 $\pm$ 1.37%, 66.27 $\pm$ 5.19%, 69.18 $\pm$ 6.58% and 78.72 $\pm$ 5.71% respectively. All 28 students who have completed the course, obtained > 50% in these assessments and were awarded the FSHM fellowship.

The students conducted a range of clinical projects including setting up clinics, hospital systems, audit of services, training programmes for staff and patients that positively impacted on the hospital services.

The feedback showed that students felt that the course was a beneficial learning experience that changed their outlook to secondary hospitals. They felt that the course enabled ongoing learning and helped reduce academic isolation. The case based approach of the modules helped them to manage patients under their care. Contact with CMC faculty enabled timely consultation that benefited patient care. The project work helped them engage in local health issues in their hospitals.

Conclusion:

The Fellowship in Secondary Hospital Medicine is an effective model of distance education for recent MBBS graduates working in rural secondary hospitals. Course participants were able to develop appropriate knowledge; skills and attitudes in relation to secondary level care and apply it in the secondary hospital where they were working. This training approach may serve as a model for other medical colleges nationally and internationally.

5- GEO SCIECE AND PLANETARY SCIENCE EDUCATION

079 BAJPAI, SUNIL (Department of Earth Sciences Indian Institute of Technology **Roorkee).** DYNAMIC EARTH AND ITS IMPRINTS ON EVOLUTION AND EXTINCTION OF LIFE. GLIMPSES FROM THE INDIAN RECORD.

India's physical as well as faunal links following its separation from the former assembly of southern continents (Gondwanaland) are a classic example of how earth's dynamic processes shape the course of biological evolution. The period from 65 to 45 million years before present is of particular interest in India's geological history, as it spans the interval from the terminal phase of India's northward flight as an isolated landmass until its collision with Asia that eventually gave rise to the Himalayas. The faunal response during this period has had profound influence on origins, evolution and the distribution of many of the modern life forms.

Sixty five million years ago, large parts of estern and central peninsular India experienced one of the greatest episodes of volcanism in Earth's history. This volcanic activity (Deccan Traps) has been proposed as the key to global climate change resulting from toxic gases released to the atmosphere, and by implications a major cause of the faunal and floral mass extinctions (including that of dinosaurs) 65 million years ago. However, a clear link between volcanism, climate and extinctions remained elusive for a long time. This link has now been conclusively established following recent work that shows that the end of the most massive phase of Deccan volcanism coincided precisely with the mass extinctions, pointing to a cause and effect relationship between the two events.

Subsequent to India's northward drift, the collision between India and Asia about 55 million years ago marked one of the greatest events in the earth's history. The process of collision caused shallowing and eventual disappearance of the sea that once separated India and Asia, bringing in its wake profound ecosystem changes. These changes include the origin and radiation of new life forms in the Indian subcontinent, as well as their dispersal to other parts of the world (the so-called *Out-of India* hypothesis). Recent data from Gujarat and the Himalaya have established the Indian was not only the cradle of biodiversity in the geological past, but actually the centre of origin and evolution of several orders of modern mammalian life (such as whales, horses, deer and humans).

080 DWIVEDI, CHANDRASHEKHAR (Department of General& Applied Geography School of Science. H.S. Gour University A Central University, **Sagar M.P.- 470003).** LANDUSE PATTERN OF SAGAR LAKE CATCHMENTS ARE USING REMOTE SENSING TECHNIQUE.

Land is the most important natural resources on which all activities are based land use. The increase in population and human activities are increasing the demand on the limited land soil resources for agriculture, forest, pasture, urban and industrial land uses.

The land use pattern of a region connotes the actual and specific use of land for which, its surface area is put in terms use. The aim of this study is to suggest proper land use for the land which otherwise has been put to some other use for which the same is unsuitable. In the present study image processing techniques are employed to carryout land use/land cover classification using Indian Remote Sensing satellite data. The supervised classification for two different dates has been carried out using maximum likelihood classifier. Total nine major Landuse/ Land cover (Level-1) classes namely –agriculture, current follow, open forest, dense forest scrab/ bushes, waterbody, barren land, settlement and tree plants in urban area could be identified in the study area Sagar lake catchments area.

081 SINGH, DHRUV SEN (Centre of advanced study in Geology, University of **Lucknow, Lucknow-226007):** GLACIERS, CLIMATE CHANGE AND SOCIETY

Culture, civilization, and development of a society is controlled and guided in direct response to the prevailing climate. It means and change in the climate will affect the culture and civilization and so the economic, political, and social aspect of the society. There are scientific evidences that many highly developed civilizations flourished and vanished due to change in climate.

Man had been controlled and guided by natural factors everywhere but this is for the first time in 4.6 billion years history of the earth that man is also affecting and controlling the natural factors up to some extent since last century. The encroachment of man in the natural system has polluted the environment, disturbed the ecosystem and affected the climate.

Scientific records for the changing climate since the origin of the Earth are abundantly clear. It is definite that it will change, but how it will change and at what rate it will change is yet to be solved. Glaciers expand and shrink in direct response to the climatic turnover hence they are considered as one of the best indicator of climate change. The high latitude glaciers In Arctic and lower latitude glaciers in Himalaya all are retreating at different rate. It is interesting to note that man is considered to be responsible for it. However, scientific data reveal that glaciers have retreated and advanced four times in the geological past and climate has changed many times even before the existence of the man on the planet earth .

The landscape of the Ny-Alesund, Arctic is carved by the repeated glaciations during the Quaternary period and the surface process evolved during interglacial stage. Glaciers expanded considerably during the so-called Little Ice, which culminated during the first suffered major recession since their 1900 AD maxima, however, about a third of the glaciers surge. Midre Loven glacier is a typical polythermal glacier. The main landforms are recessional moraine, terminal moraine, medial moraine, hummocky moraine and, trust moraine. The analyses of these landforms are helpful in deciphering the palaeodynamics of the glacier and nature of climate change.

082 SRIVASTAVA, PRADEEP (Wadia Institute of Himalayan Geology33, GMS Road, Dehra Dun 248001). **RESPONSES OF GANGA RIVER SYSTEM TO VARYING CLIMATE THROUGH THE LAST 40000 YEARS.**

Fluvial incision and aggradation plays a crucial role in the development of landscapes. The climate and tectonic forces, which act on the river catchment, decide the amount of river incision and control rates of erosion and sedimentary budget of world oceans. The global climate is known for its variation in terms of rainfall, temperature and eustatic sea level. Important climatic events as studied in oceanic records since 128 ka are: OIS-5 (128-75 ka); the last interglacial; OIS-4 (75-57 ka) relatively dry phase, OIS-3 (57-25 ka) relatively humid phase; OIS-2 (25-10 ka) last major glacial phase; OIS-1 (10-0 ka) present interglacial phase. Specially, the palaeoclimatic scenario during the last 15 ka, based on continental pollen and ocean records, suggests that following the Last Glacial phase, Indian summer monsoon strengthened ~12 ka B.P., with peak rainfall at ~9 ka B.P., and has been stable since then. A river responds to such varying climate conditions and acts as a conduit for sediment erosion and evacuation. A drier climate may lead to the enormous production of sediment but poor river discharge may hinder the sediment erosion and evacuation process, and eventually may lead to valley aggradation. Under wetter conditions the river will not only flush out the produced sediment but also will incise the bedrock to the depth of the amount of uplift or more.

Himalaya and adjoining Ganga basin is an ideal laboratory to understand the climatic responses of a large river system. An initiative combining field investigations and chronological studies on the geomorphological and sedimentological archives of major Himalayan river valleys of (i) Spiti (Arid-Trans-Himalaya, rainfall ~100 mm/a), (ii) Mandakini, Alaknanda, Bhagirathi (NW Lesser Himalaya, rainfall ~1200 mm/a), (iii) Marsyandi (Humid, Central Himalaya, Nepal, rainfall 2000 mm/a), (iv) Teesta (Eastern Himalaya, Sikkim, Rainfall ~2500 mm/a) (v) Kameng and Brahmaputra (NE Himalaya, rainfall ~3000 mm/a) indicated that:

1 The River valleys in terms of aggradation and incision oscillated in-phase with the changing climate during the last 40 ka. The climatic transition from the last glacial phase to rainfall Maxima of Holocene was characterized by large-scale valley aggradations. The Spiti River showed deviation conforming to present day rainfall conditions. The wetter conditions of the early Holocene led to increased stream power and river incision.

2 The rivers in NE Himalaya exhibit several phases of incision that are synchronous to aggradation in west. This is due to relatively high rainfall in the region that did not reduced below a threshold even during the drier phases of last glacial phase. This points towards relatively high erosional stress and associated deformation in the NE Himalaya.

083 PANDEY, ALOK (Department of General& Applied Geography School of Science, Dr. H.S. Gour University (A Central University Sagar (M.P.- 470003): TRAMSFORMATION OF RURAL ENVIRONMENT: A CASE STUDY OF GEOGRAPHICAL ANALYSIS IN BUNDELKHAND REGION (U.P.)

The interaction of human activities with the natural landscape and related natural process has transformed the Rural Environment with the emergence of diverse activities. Transformation of rural environment is a holistic process, water, food, energy, health, technology, agriculture and education all play a key role in reducing rural poverty. The process of rural transformation a complicated interplay of shift in industrial and other activities, urbanizing the character of socioeconomic organization, changes in landuse pattern, consumption, distribution pattern and growth of population has provided a key to the economic development. But this has caused and is causing the changes in the natural as well as social environment.

Present paper concerns a study on transformation of rural environment in Mahoba district is a part of Bundelkhand region, India. The study will help to understand and study the impact of diversified development activities and to gauge the process of transforming the rural environment along with the attitude and involvement of local people and that of the role of government functionaries. Attempt will be made to stratify the study region based on the degree of transformation and to measure the intensity, magnitude and rate of transformation. It will also identify the potential areas for development in the study region

PANEL- VII
AGRICULTUREAL SCIENCE EDUCATION

084 JANGRA, MOHAN S. (Horticultural Research Station, Dr. Y.S.Parmar University of Horticulture & Forestry Seobag, PO **Neoli – 175138 Kullu (HP)**: AGROMET ADVISORY SERVICES: AN INNOVATIVE APPROACH TO MAKE PEOPLE ACQUAINTANCE WITH CROP-WEATHER SCIENCE IN HIMANCHAL HIMALAYAS

Agro meteorological research has progressed considerably and several advances had been made in the recent decades in this field. But Indian farmers are still depended on seasonal rains, which are highly variable both in time and space. Inclement weather events such as, drought and floods, cold and heat waves, hails, squalls, tropical storms severely affect the production. Precipitation, temperature, humidity, wind speed and direction, drying conditions, dry and wet spells are the most important weather elements information about who could play a significant role in farm planning and operations. Their malevolent effect may be partially reduced if the occurrence of the events is predicted in advance and farmers are suitably advised to take ameliorative measures. NCMRWF/IMD is providing weather forecast of six weather parameters (cloud cover, precipitation, wind speed & direction, maximum & minimum temperatures) in five days advance to Agromet Advisory Service Units (AAS) all over the country. Total 102 AAS units have been established at different agro-climatic zones of the country and the process is continuing. There are four such units in Himachal Pradesh. These AAS units are preparing an Agromet Advisory Bulletin and issuing to farmers for imparting the crop-weather relationship knowledge so that they can adjust their farm operations in the light of coming weather. This enables farmers to reduce weather hazards on crops and to manage their valuable resources more efficiently. Agromet advisory bulletins guide the cultivators in advance for doing/adopting different cultural operations like sowing, transplanting, applying irrigation and fertilizers, spraying of pesticides, hiring of labours etc in relation to coming weather. Economic impact assessment and feedback of the farmers covered under our AAS unit, Seobag showed that they are getting economic benefits in terms of saving of seeds, fertilizers, irrigations and pesticides doses. They very much appreciated the services and using the advisories in their day-to-day farm operations. Feed back analysis showed that farmers are using and adopting the information provided through AAS bulletin and rated it good to excellent. All the selected farmers/orchadists are appreciating the AAS bulletins very much and said that it must be continued for the benefit of the farming community. More and more orchardists are approaching us for including them in the service. Now the bulletin is being published in different news papers in and also broadcasted/telecasted from the All India Radio and the Doordharshan for real time dissemination and wider benefits of the community.

085 KAUSHIK, R.A. AND A.K. SHUKLA (Department Of Horticulture, Rajasthan College of Agriculture, Maharana Partap University of Agriculture and Technology **Udaipur Rajasthan).** HORTICULTURAL EXTENSION EDUCATIONAL AND TRAINING PROGRAMME FOR THE DEVELOPMENT OF HORTICULTURE IN RAJASTHAN.

Rajasthan is basically an agrarian state where 90 per cent cultivable land is under field crops, mainly cereals. This has resulted into many problems such as environmental, degradation of natural resources, and economic sustainability. State has significant deficit in fruit demand at the current consumption rate (22.67 lac tonnes for fruits and 55.16 lac tonnes for vegetables). India is the second largest world producer of fruits and vegetables with an area of 3.94 and 6.24 million hectares, respectively. However, in Rajasthan, Horticultural crops are grown in an area of about 10 lakh hectares with an annual production of about 14 lakh MT. There is a great need and scope to diversify the existing cropping pattern in Rajasthan for which extension education can play a pivotal role. Extension education is very closely linked with human resource development (HRD), which is a backbone for the success of any development program. Rajasthan state has a strong squad of extension workers who can motivate the farmers for

adopting horticulture as entrepreneurship. The network of trained horticultural extension workers of the Directorate of Extension Education, Maharana Partap University of Agriculture and Technology has been assigned the task of providing scientific knowledge on various aspects of horticulture to the rural people for the development of horticulture through demonstrations, exhibitions and *kisan melas/diwas* (farmers fairs). The success in increasing the area under horticultural crops depends upon the active participation of a large number of farmers. Training to farmers, farm women and unemployed youth through well planned short/long duration courses, field demonstrations and success stories is also being imparted by Krishi Vigyan Kendras (Agriculture Science Centres) which are established at district headquarters by Maharana Partap University of Agriculture and Technology, Udaipur and are funded by Indian Council of Agricultural Research (ICAR). For the promotion of horticulture in the state of Rajasthan, various horticultural extension and training programs are being carried out by the University which are discussed in this paper.

VIII- SOCIAL SICENCE EDUCATION

086 AGARKAR, S. C. (Homi Bhabha Centre for Science EducationTata, Institute of Fundamental Research, Mankhurd, **Mumbai 400 088).** AN INITIATIVE INTO DEVELOPING OPEN EDUCATIONAL RESOURCES IN SCIENCE FRO INDIAN SCHOOLS.

Homi Bhabha Centre for Science Education (HBCSE), a constituent unit of the Tata Institute of Fundamental Research (TIFR), Mumbai has launched an ambitious programme to design and test open educational resources for schools (OER4S) in science. These are web-based resources developed collaboratively by academicians, teachers and enthusiastic parents. They are made available to all the stakeholders (teachers, parents and students) through the distributed classrooms set up by the Maharashtra Knowledge Corporation Limited (MKCL). The programme aims at supporting Indian school system to offer quality school education. The philosophy of the programme, the strategy of its implementation, mechanism of obtaining feedback from stakeholders for mid-course corrections are described in this paper.

087 BARIK R. (P.G. Department of Chemistry, Bhadrak Autonomous College, Bhadrak – 7561000, Orissa): NATURAL SELECTION AND SCIENCE EDUCATION: A CO-RELATION MECHANISM

Around 30-45% of the students, securing more than 80% marks in their HSC examinations from the rural belt schools, get failed in +2 Science examinations. IIT system of education go according to their cumelative performance index (CPI). The students who do not secure their standard CPI (~ 7.5), are thrown out of the institutions. Reservation policy for underprivileged students although is a necessary criteria for our National integration, many substandard primary and secondary school education systems in the rural belts of our country weaken their standard of genetic exposer. As a result they fail to compete with the naturally privileged genius in basic science curriculum, particularly at higher education levels.

The technological developments of our country depended stand on the developing of the basic science educations like Physics, Chemistry, Mathematics, Biology etc. However the unemployment scenario of India now a days does not attract our genius to go for pure basic science educations programme. Since IT sectors of our country provides some job opportunities, our students are getting more based education programs only. In case we wish to give importance to creativity and innovation along the dimension of basic science educations, our Nation should create sufficient employment potential for the same. Otherwise our genious would always prefer to fly abroad to exercise their genetic potential.

On the other hand, we have already said that the Nature contains innumerable potential holes and potential mountains for our student community to over-come through out their career. Therefore, the quantum probability in natural selection would decide the struggles of our present generation student community to fluoresce in basic science programme. In cash, we wish to give an up-ward momentum to basic science education, our Nation should consider naturally selected previleged for scientific innovation and creativity. Otherwise the Nature would apply its creative and destructive mechanistic principle to generate a normalized social structure by shifting the equilibrium constant more towards the destruction side.

In contrast, information resolved sound waves manytimes motivate the children of age group 3-15 to improve their genetic potential via mutation mechanism. Thus our nation should give emphasis to improve the standards of the students of rural belt schools via motive implantation techniques.

088 CHANDRASEKHAR, D. (4-75, Ravuripeta **Vetapalew -523187 Prakasaw** District **Andhrapradesh).** QUESTIONING THE CONTENT: SOME FUNDAMENTAL ISSUES IN SCIENCE EDUCATION.

I. First of all, it is imperative to reexamine our understanding of science. Science is defined as 'the systematic study of the structure and behavior of the physical and natural world through observation and experiment'. In its broadest sense it also encompasses the application of the knowledge thus acquired. Taken purely in this spirit, science can be used for both right and wrong purposes. No sane person would say that it should be used for both. Then we cannot proceed further without understanding how science can be used only for right purposes. Science Education should also include sensible use of science. Otherwise there is a danger of falling into the slough of scientism.

Certain premises that we take for granted:

1. There is an undisputed or accepted body of knowledge called "science".
2. Science has an intrinsic nature of doing nothing but good to mankind.
3. Science has undisputed intentions, so it serves undisputed interests.
4. Since growth of science leads to the wellbeing of mankind, there should be no control on it.

These are some deep-rooted beliefs in the channels of science education that are to be thoroughly reexamined. Most people, who are in the undertaking of science education, are not aware of the dangers of a superficial and fragmented approach to science.

II. The purpose of Science Education is not different from the purpose of education in general. The purpose of education is to unfold new levels of human potential and use its creative powers for the survival and well-being of mankind. Then the aim of science education must be to promote welfare of the whole mankind, not of a tiny minority against the rest of the society.

III. What should be the prime task of science education?

a. To facilitate the awakening of scientific thinking or just to impart scientific knowledge?
b. Is there a place for wisdom, will and courage in science education?

Science is usually considered as a discrete branch of knowledge. On reflection one can understand that this is not the case. Scientific thinking is inherent in human thought and can be traced in every movement of our life.

It is true one learns something when one is faced with an existential problem. This understanding is totally missing in our system of education; readymade packages of 'science' displaced the real problems faced by the learner. As a result, no wonder, curiosity dries up in the learners at an early age. This is why no student of science takes up the issues that plaque the society he lives in. He is obsessively involved in getting a job. He always looks *up* for his own career, never *around* him.

IV. Scientific knowledge has never been undisputed, even at the fundamental level. But our institutionalized science education blurred this truth. This has led the learner to depend on the authority and there is little encouragement for verification of truth by the learner himself.

There has been a continuous counter current, from various forces in different guises, to weaken, defeat or destroy scientific thought in every phase of man's history. Ours is no exception. In order to make real progress, we need to launch a combat on these forces, on ideological level, in defense of scientific thought and make science education a dynamic living endeavor.

089 CHANDRASEKHAR, D (4-75, Ravuripeta Vetapalew -523187 Prakasaw District Andhrapradesh). RITULIZATION OF SCIENCE AND DEGENRATION OF MAN

Science and technology have enjoyed greater regard than anything in the past two centuries Science has unlocked many riddles that wracked human mind for many millennia regarding the universe, nature and man himself, Science has made enormous impact on human life. Its effects are multidimensional, particularly in the modern era. Along with sweeping changes in our material life, its influence permeates through out our relationships, our relation with nature and more importantly on our thinking patterns.

The pace of growth and overwhelming effects of science are such that we have become blind to its underlying fallacies, failed to recognize its limits and disadvantages, and are eventually driven out of balance.

All ideologies, institutions and man-made systems tend to build up a kind of insulating armor around them distancing themselves from other ideologies, institutions and system. They develop perpetual self- supporting and protective mechanisms irrespective of rational validity of their purpose and function landed this helps them grow in the beginning to some extant. After a certain threshold the insulation gets thicker and deprives them of necessary intercourse with other ideologies, institutions and system. This isolation leads to stagnation and stagnation inevitably results in deterioration. All stagnated ideologies, institutions and systems continue to survive by taking refuse in ritualistic practices.

Ritual is defined as a series of actions performed according to a prescribed order. The nature of ritualistic practices can be easily understood in the context of religion. Here are some significant characteristics of ritualistic practices:

(1) They take for granted not only the process but also the very purpose of the action without re-examining them.
(2) Their self identity, survival and expansion take precedence over their intended purpose.
(3) They gradually retreat from their renewed effort of reaching out a coherent world view and end up in a fragmentary world outlook.
(4) Dissonance between their word and practice, and loss of integrity becomes common place.
(5) The longer a ritual is practiced, without undergoing any fundamental change, the more it becomes rigid and closes doors to new possibilities.

Modern science has acquired all these detrimental qualities. As a result:

(a) we are trapped in a mechanistic and atomistic world view. Man is reduced to an insentient automaton or to a bundle of appetites. He is degenerated not only physically but also genetically intellectually, morally and spiritually.
(b) We tend to believe that increase in production of goods can solve all human problems; in order to maintain man's well-being and happiness we must keep on creating new goods. Consumerism and obsolescence have become the chief characteristics of modern life.
(c) Our paradigm of education is very much akin to the modern industry, whose sole purpose is to produce homogenized goods. We have come to believe that intelligence and even enlightenment can be produced on assembly lines. Present education system can only produce limited versions, if not distorted versions, of human beings.
(d) Our health care systems have become production centers of new disease and perpetually-sic people. The main threat to modern man's health is his deteriorated organs- not bacteria or virus that come form out side.
(e) Our obsessive indulgence with production of goods, our spirit of conquest and hostility to nature have blinded us to the simple truth that natural resources have their limit and they can eventually exhaust; that infinite development cannot fit to a finite world. No wonder we are at the door-step of a catastrophe that may even wipe out human race from the planet earth.

Our problem is no more underdevelopment but lopsided development and over development in many aspects. The present crisis necessitates a basic tremor in our thinking, on overhaul of all our ideologies, institutions and system, which are under sweeping influence of

modern science. A wakening of mankind to its full potential- not creation of more new goods gadgets- can save us from the predicament.

090 CHANTIA, ALOK (Dept. of Anthropology Sri J.N.P.G.College, **Lucknow**). ANTHROPOLOGICAL SCIENCE IN INDIA: ISSUES AND CHALLENGES.

Culture is also a kind of education, but it is degenerating nowadays because an individual cannot survive on earth or earn livelihood under the carrying capacity and limit of culture. Because of this factor acculturation ,modernization, sanskritization, and globalization came into light to retain the original content of culture along with smooth survival. This philosophy can be visualized with regard to science education. India is a hugely populated country .It is not hypothetical to imagine that science education can provide bread and butter to all. Anthropology is knowledge based instead of job oriented. that is why these days' students are shying away from this subject. Students are not very much interested in it due to unchanged course content and its abstractness. A student does not find any correlation between Anthropology and job requirement. That is why quality of students is declining in this field day by day. Anthropology as a subject studies man in totality. Here totality denotes archeological, physical and social anthropology. But these sub branches do not provide any good future to the students. A student of anthropology cannot get a job either in archeology or in biology with a B.A. Degree, though he studies whole process of preservation, excavation in archeology and knows all anatomical measurements, pathological tests and especially human genetics. After studying genetics in B.A. standard, a student cannot get admission in forensic science. Anthropology provides intensive knowledge of the subject, its participant observation test is very useful for BPOs, MNCs but due to advent of subjects specializing in commerce, marketing and management it is not showing its full reflection in the society. Auto anthropology is nothing but applied geography and government can plan many rehabilitation programmes with the help of auto anthropology. Not a single policy or plan is absolute, dialogic anthropology can be utilized for framing a particular programme or policy for the betterment of the society. Anthropological jurisprudence can also be utilized for explaining various functional errors in the structures of society like marriage, family and kinship. In U.P. number of students are decreasing day by day in anthropology as various universities and degree colleges are providing a B.A. Degree in Anthropology. So it is very important to discuss how Anthropology as a science discipline can maintain its relevance and significance. It is well documented and analysed that anthropology is not merely associated with academic anthropology. Many applied and action oriented branches of anthropology can make a better platform for students. For example, maket anthropology, business anthropology, family, marriage management as MBA subject ,use of ethno medicine in ayurveda, forensic anthropology, biochemical anthropology, sociology, dermatoglyphic with astrology, human origin, evolution may be better option for students in different types of jobs. Today we are leading towards a knowledge based society. Today we are facing an era of globalization, privatization liberalization. Research methodology with anthropological approach may be a boon for marketing of services. BPO and multi national can appoint anthropologist as production promoters as general motors, Xerox etc. international companies got benefited by it, but all this can materialize if course content of anthropology is modified.

Today is the time of marketing, even of subjects, how to popularize a subject and create an interest with space and pace for job. How anthropology as science can prove its relevance today in the era of globalization? Which type of change is required in its content to generate interest amongst youth? How this subject can be studied in totality i.e. as a good source of fulfilling basic requirements of life like food, cloth, protection? How this subject can be managed to fulfill the requirements of various job sectors? Whether all this requires marketing of this subject in any way? How anthropology can be verv useful subject of science in the process of modernization? All these points will be discussed in detail in present paper.

Keywords- Anthropology, Science, Education, Utility, Opportunity,

091 GHATAK, SANDIP KUMAR (ASANSOL GIRL'S COLLEGE, ASANSOL-4, BURDWAN, WEST BENGAL.PIN-713307): PERCEPTIONS OF THE TEACHERS'S ABOUT THE SCIECNE EDUCATION IN SCHOOL IN WEST BENGAL

The present condition of the science education in school is not satisfactory and it is popularity is declining day by day. The science department of different colleges are suffring from the lack of students strength. The students are taking science as a ladder for their career. Lack of proper infrastructure for science education, non existence of good teacher who can effectively impart science education to the students, defectives syllabi and books are also responsible for the present dismal picture of science education in school in West Bengal. Purpose of the present paper is to present the perceptions of the teacher of different schools of West Bengal regarding the present position of the science education in schools.

092 GUPTA ANSHUL AND AGARKAR S.C. (Homi Bhabha Centre for Science EducationTata Institute of Fundamental Research Mankhurd, **MUMBAI-400088**). STUDENTS IDEA ABOUT ROBOT AND ITS UTILIZATION: A STUDY

Robot is a complex association of Physics, Mathematics and technology and it always remained the centre of attraction for young children. They think of robot differently. To understand their conception about the potential uses of a robot, a study was made at Homi Bhabha Centre for Science Education, Mumbai. Children visiting the centre were asked the questions about would be uses of a robot if they are provided with one. They were allowed to submit their responses in written form. Students' sample includes young middle school students of three different socio-economical backgrounds mostly dominated by the impression of technology projected by science fictions and entertainment media.

It was found that children's conception about robot is primarily governed by fantasies originated from television programme and movies. Instead of their understanding of robot as a multi tasking human help they visualize robot as a humanoid controlled by oral instructions.

Analysis of responses revealed children's misconception based on three parameters. It is also found that the applications of very fundamental aspects of Physics and Mathematics lead them to distinguish among different operations carried on by an elementary robot.

A demonstration using a set of wooden models exhibiting the elementary movements of robotic arms was arranged for the benefit of students. These models were constructed to let the children understand how robotic arms follow mathematical commands. How instruction can be prepared in different coordinate systems was also demonstrated.

Again the children were asked to justify their responses based on basic robotic actions using the demonstrating tool. Children's fantasies of robot were replaced by quest to search for small tasks and assigning instructions to the models.

It is suggested that introduction to robotics imparted in the technology section of middle school should be made through idea of specific uses of robot followed by its mechanical and/or electrical equivalent process. Robot can be learned better as a physical agent rather than a complex humanoid. Young children are able to determine the behavior of these agents by the choice of robot's elements and the manner in which they are connected. Incorporating the focus-reflect-apply learning cycle children can be encouraged to design or construct small tasking agents. Application of a physical phenomenon can be understood using such agent and vice-versa.

093 GHARE, DHANANJAY B. (Indian Institute of Science, **Banglore**): REMODELED LOOK OF INDIAN EDUCATION SYSTEM DURING THE 21ST CENTURY AD

We very proudly learn in History that **"For Thousands of Years"** (before the British Raj), India Played the Role of the **"guru"** (of then- then latest and best form of Education) on the Global Scenario. In those days, the **'Temple'** were playing the Role of School Buildings for

(c) Seriously Registered (Accepted by Guru's) Students in the Morning and

(d) For adults in the evening when education was imparted mainly through "Entertaining Programs" involving Dance Drama bhajana's keertana's' pravachana's etc.

"Teertha_Xetra" Temple were like **Universities** and special gurukula's or aashrama's of Sages were also like Universities- Research Laboratories etc.

The Structure of the Traditional Indian Education System, was heavily weakened, during the Several Centuries Period (1100 to 1800 AD) of Muslim Invasions, Rules and Prolonged Political Instability Swami Vidy Ara Nya teertha and samartha ramadasa tried to stop the erosion to some extent.

With the British Raj, the entire "Traditional_ Indian_ Education _System" was totally away and officially discouraged & demolished.

However, during the British Raj, Lokamanya Tilak and his friends under the leadership of Chiplunkar started New Educational Institutes with **Western Styled Syllabus & Indian Flavor of Teaching**. Madan Mohan Malviya started similar Institution in Banaras and Tata's House Founded " Indian Institute of Science" at Bangalore.

After Independence in 1947 AD, Pandit Jawaharlal Nehru got **Fiver IIT's established in New Delhi, Kanpur Mumbai, Madras (Now Chennai) and Kharagpore (near Kolkatta)** and a tradition of World Class of Highest Level of Technological Education Institutions (though on Western Style) got established again.

A vast majority of the students who graduated from these Institutions were absorbed by high salaried Jobs in Technological Advanced Countries Like USA, Canada, UK (and also in Japan, Singapore, Australia France & Germany etc. to a smaller extent.)

In the **1950's to 1970's** Indian universities and Education Institutions were attracting Students from east Asian, West Asian and African countries and **there was a Flavour of India Playing a Leading Role in International Education Senario, at least for the Nonaligned Developing and Under developed Countries.**

As these Countries established their own Educational Institutions, this process got drained off and today Indian Universities are hardly attracting Students from Foreign Countries (in any major or significant number).

With Desktop _ PCs, Laptops, Notebook_ PCs, Internet and TV Channels, the Role of Teachers in the School Building is bound to change and the World is moving towards Household Drawing Rooms and Bed rooms as the Basic Schooling premises for the primary and High School level Education.

With in a few forthcoming Decades, School Building will be required mainly for

(c) Laboratory Experimentations- Demonstrations &
(d) Conducting Sports, Gatherings, Examinations etc.

Hard Copies of Printed forms of Books will slowly disappear and **CDROMs and Pen Drives** will contain **"Whole Libraries of Books" in the Pockets of the Students** .

How the Indian Society and Culture will & Should react to these " Revolutionary Changes" bound to happen in the Global Education Scenario and

Some ideas on **"Re_ gaining"** the **Foremost Leadership Position of 'guru' on Global Scenario by (a Indian as a Nation and b) the Indians as a community** (where ever they are located: in the **"vidvaan _ Sarvatra _ Poojyate", "Vasudhaiva_ Ku Tumbakam"** Spirit) in the Focal Theme of the Paper.

094 KUMAR, PADHI SAMBIT (Department of Education, Guru Ghasidas Vishwavidyalaya **Bilaspur -495009**). SCIENCE EDUCATION AND ITS SOCIAL RELEVANCE: A STUDY WITH SPECIAL REFERENCE TO INDIAN SCHOOL

In 21st century, science would require to be free from elitist aberrations and career building agenda of the few bright students only. Without being a privilege, science and technology literacy would be a basic requirement for all and be prioritized in every walk of life to cope with the changing demand of time. Science education in general, and teaching and learning of science in particular is in need of overhauling and a paradigm shift. The curriculum and teaching learning situation in India is quite grim. There is lack of clarity and an over all confusion of the aims and objectives and content and process of sciences education. Teaching is hardly assessed against learning. The major educational failure of the traditional science curriculum concerns the dishonest and mythical images about science and scientists that it conveys. Consequently, some strong student's loose interest in taking further science classes, some students become interested in science for wrong reasons and many students become citizens illiterate with respects to the nature of social aspects of the scientific enterprises. Most students tend not to learn science content meaningfully due to lack of its relevance to personal and social life .it is increasingly felt that science has failed to be popular in the society. Science teaching and teachers have lost their credibility. Science curriculum becomes mechanical, monotonous and burdensome without bringing any excitement in the students. It is no longer desirable to teach factual knowledge without the students feeling personally involved. It is also not admissible to practice or teach sciences without taking into consideration its profound consequences on life and living of people in the society. It has become imperative on the part of science to break its ivory tower seclusion and privilege of being elites' property. Now science needs to address the equity concerns of democratic society and search its identity in the common mass. 'People' Science' is the call of the day. The constitution of India in its Section of Fundamental Duties Arrticle51 (A)- h, categorically states that:

"It shall be the duty of every citizen of India: to develop scientific temper, humanism and spirit of inquiry and reform"

Thus, it becomes mandatory on all of us to look for appropriate strategies through our science education for development of scientific temper in every citizen of India.

095 K. VINISHA and RAMADAS J. (Homi Bhabha Centre for Science Education, TIFR, V. N. Purav Road, Mankhurd, **Mumbai 400 088). VISUAL REPRESENTATIONS OF THE WATER CYCLE IN SCIENCE TEXTBOOKS**

Visual representations including photographs, sketches and schematic diagrams are a valuable yet often neglected aspect of science textbooks. Visual means of communication are particularly helpful in introducing abstract concepts. For effective communication, visuals and text need to be appropriately integrated within the textbook. The "water cycle" is the first abstract cycle to be introduced a part of the curriculum. Our interest is in studying how the water cycle is treated in the school science curriculum, what types of visual representations are used, and how effectively text and visuals are integrated in the textbooks over the school years.

The NCERT textbooks from Classes 3 to 10 are the main focus of this study. In addition we analyse the Maharashtra State Board textbooks and draw comparisons with the treatment of the water cycle in the NCERT textbooks. Finally, we make some observations on the treatment of the water cycle in Small Science (The Homi Bhabha Curriculum for Primary Science) for Class 4, and suggest implications for use of visualisation to understand the concept of the water cycle.

096 Mishra Bana Bihari (DEPARTMENT OF EDUCATION MIZORAM UNIVERSITY **AIZAWAL-796001, Mizoram).** QUALITY SCIENCE EDUCATION IN SECONDARY SCHOOLS OF INDIA.

Since independence with the development of science and technology, India has acquired considerable self-reliance in the areas such as agriculture, energy, communication, medical, meteorology, defence, industry, engineering, technology and the like. In order to address the problem of illiteracy it has made great strides in the growth and development of education starting from elementary to higher and as a result of which we have vast network of education. However ,issues in education have continued to remain as access, equity and quality. There remains wide gap on these issues between rich and poor, men and women, rural and urban, and upper and weaker sections. In view of the ever-increasing educational institutions and ever-increasing student populace the issue of providing quality education has suffered a setback. So the need of the hour is to emphasize the quality in education at all levels in every corner of the country so that we can transform our huge human resource into an asset. The concept of quality in education may differ from person to person, but it is universally accepted that quality is an on going multidimensional process. For improving quality in education there needs to be paradigm shift from old practices to new in its parameters so that the graduating students can compete in the global market, in the present context, in terms of their knowledge, skills and other competencies. Thus it connotes totality of features and characteristics of students passing out of educational institutions. In the present era of liberalization, privatization and globalization (LPG), 'quality' is enchanted as catchword of every product or service and so also of education. Quantity, equality and quality are described as the 'elusive triangle' of Indian Education. National Curriculum Frame Work-2005 (NCF2005) has taken note of this triangle and has recognized the vital role of science as a subject of study at different levels of education in the attainment of educational and societal objectives. The NCF2005 has made several observations and suggestions for strengthening science education at different levels of schooling. Recently National Knowledge Commission (NKC) has recognized the science and technology in the centre of its concerns for its knowledge projects and to use them maximally for the betterment of the lives of the people and to develop the scientific temper with the citizens of the country. In the present article an attempt has been made to discuss about the parameters of quality science education at secondary level of education and to analyze the problems that stand on the way which need to be addressed in order to bridge the divide between the genetic and locale based haves and have-nots in terms of science education, develop scientific temper with future citizens of our country, and achieve the target of knowledge society by 2020.

097 MISHRA, SHUBHRA And SHOME, SAURAV And AGARKAR, S. C. (Homi Bhabha Centre for Science Education,TIFR,V.N.Purav Road, Mankhurd, **Mumbai 400 088).** VOCATIONALISATION OF SECONDARY SCHOOL EDUCATION AS AN INSTRUMENT TO BRING THE STABLILITY IN INDIAN ECONOMY

The mentioning of implementing vocational education in Indian school has been found in various Education Commissions both in pre- and post-independent India. This paper has presented a review of all education commission reports those had talked about vocationalisation of Indian school education. Particular emphasis has been given on the reports those suggested implementing vocationalisation of secondary school education. Gandhi's Nai Talim and its relevance is addressed with an attempt to resolve the apparent contradiction found in Zakir Hussain Committee report in response to the Nai Talim. Vocationalisation of school education depends on various factors which obviously comes under the socio-economic structure and historical development of the society. The compartmentalization of manual and intellectual work on the basis of caste deterred both the intellectual and architectural development. After British colonization India has faced the threat of losing her indigenous knowledge and technology. For the first time the Indian market was exposed to severe competition with the western product and most of the indigenous knowledge and technology came to an extinction. The inevitable consequence of the spreading of capitalist market in Indian context has also been an issue of concern. The post independent development is largely aimed at finding a short term charismatic result sacrificing the long term developmental view as

per the demands of the time. As a result, in the name of development the disparity across various socioeconomic classes gradually increased and brought out social conflict. According to Kothari Commission Report, Indian education system is still retaining its feudal structure. After almost 60 years the young people of the country are facing difficulties in getting a job even after completing a university degree. Several attempts has been made to develop the educational scenario of the country by setting up multiple education commissions. The education commissions' voluminous reports have been ornamented through organizing intellectual debate but never came in practice and never asked for evaluation. Within this time the wave of globalization and limitless consumerist mindset has almost engulfed the major portion of the country's human resource. In this critical juncture, it is essential to look back the educational policy and find a way out to mitigate the detrimental effect of transborder flow of apparent luster in consumerist life style. Relating education with ground reality on rational and sustainable basis is an urgent need and the paper proposed a way that how it can be achieved in present situation. The role of vocational education has not been viewed as merely a job oriented course but goes beyond the traditional view. The paper has made an effort to establish the vocational education as a pedagogic tool and possibility of infusing it in the Indian classroom settings with appropriate modification in the present system.

098 PAUL, D'SOUZA (61 Shek Mun Kap, Lantau Island, Hong Kong. (852) 91676367 Visiting Faculty K J Somaiya College of Education, Vidyavihar, **Mumbai).** ATTITUDINAL CHANGE IN TEACHING OF SCIENCE:A HUMANISTIC PERSPECTIVE

"You are your own forerunner and the towers you have built are but the foundation of your giant self. And that self too shall be a foundation" – Kahlil Gibran

This paper deals with the need to bind scientific axioms and facts with the learner's mind and spirit. It exhorts teachers in modern day India not only to be a tower themselves in their field of excellence but also be willing to let that tower be a foundation for the sake of science, education and humanity. Science being about discovery, spirit of free enterprise and creativity, the paper advocates the urgent need for teachers to lead learners to develop a sense of pride in discovery through self enterprise which it argues will be possible only when teachers themselves rank high on self-esteem and understand the self-esteem needs of those under their tutelage. For this to be a reality a teacher-education system should be in place where personality development and self-esteem needs are focused intricately along with pedagogy; not through programs, preaching and teaching but through actions during the normal course of the entire curriculum transaction. Since values are to be caught and cannot be taught, the paper highlights the importance of teacher-educator attitude going a long way to either nurture or shatter the self-esteem needs of these impressionable to-be-teachers.

A humanistic approach in teacher-education will produce educators of towering personality willing to let learners take the centre stage during the journey of self discovery and creativity, which learning science is all about. Thus a humanistic based education, more so teacher-education will throw up threads that would be integral to an awe inspiring tapestry of education: an education more universal, democratic, creative and people oriented.

099 PAYEL BANERJEE (Faculty of Education Banaras Hindu University **Varanasi 221005).** DEMOCRATISING SCIENCE EDUCATION IN N.C.F. - 2005: HURDLES OF INSTITUTIONAL PRACTICES

The study intends to evaluate the suitability of the present institutional practices in India for the kind of science education recommended by the recently developed National Curriculum Framework -2005 by N.C.E.R.T. This framework advocated for a system of science teaching which is different in many ways to that of the prevailing structures for science education. It recommended for following constructivists' paradigm – a truly democratic practice of science teaching. It has also brought about striking modifications in the content, nature and the format of the science curriculum and the textbook to make the system closer to the teacher and the taught. The success of the theoretical framework will depend on the successful

transmission of the aims and assumptions with the authenticity of the theory in the background, from the plane of the planning to that of the execution. The present research studies the problem in two ways.

At first, the study seeks to know whether the science teachers (1) have meaningfully understood, accepted, agreed to or benefited from the propositions of the National Curriculum Framework -2005 and from the modified format, structure and the contents of the new curriculum, (2) perceived the reflection of the same in the Science Textbook (which is supposed to be the materialised example of the abstract theories behind the framework). An opinion survey (partly structured and partly open in nature) was conducted on 530 science teachers, teaching at secondary level, from schools under C.B.S.E. (K.V.,N.V. and private schools) and non-C.B.S.E boards (state board schools of Uttar Pradesh and West Bengal). An Opinionnaire, used for the purpose, contains 24 structured and 12 unstructured items.

Secondly, textbooks concretise and exemplify the basic theory. To most of our teachers, the textbook becomes the *sum of learning experiences*. Thus, we need to know how much successful they are, in their purpose. The study takes up, among various other important dimensions, the issue of larger inclination towards promoting '*doing science*'. A serious obstacle before democratic science teaching in Indian classrooms, diagnosed by the report of *Yash Pal Committee* (1996), was that, the scope of escaping the hands on science teaching-learning comes due to the presentation of the activities in the book in a non-operant manner. Since the report was one of the foundation- researches for the N.C.F.-2005, we must see (3) how much its suggestions were reflected in the new textbooks. For this purpose, the *contents* of the chapters on Physical Science from the Science Textbook of class IX^{th} and X^{th} by N.C.E.R.T. were *analysed*. The tool used is a checklist, containing various dimensions of the science process skills. Through Content analysis, occurrences of different skills, the textbook should incorporate, were marked, under three categories -- operant, non-operant and exemplars and were counted using tally marks.

From the responses to the 22 structured items of the Opinionnaire, it was observed that (1) nearly 80% of the secondary teachers found 13 to 15 issues, out of the 21 chosen in the Opinionnaire, were incorporated in the Science Textbook to some extent, 3 to 5 issues to a large extent and 4 to 6 issues were not incorporated at all; (2) about 80% of the secondary teachers expressed their view in favour of introducing a new chapter to explain the nature and structure of Science and Technology at secondary level.

From the responses to the open ended items of the Opinionnaire and to the personal information, it was found that (3) almost 85% of the secondary teachers neither supported the reduction of curriculum load, nor liked the format and language of the new Science Textbook. Most of them are also found not to be well-informed about the N.C.F.-2005 and about various issues of the curriculum reform. The responses indicate that it is their ignorance about and lack of understanding the basic assumptions of this reform, which is one of the prominent reasons of their disagreement with the policies and resistance to the change.

The content analysis of the Science Textbook reveals that (4) the activities in the non operant category out numbered those in the operant category. The activities in the exemplar category were very few in respect to the other two.

The findings, by comparing with the systems of science education in other nations, suggest for a need of strong feed-back communication between the plane of curriculum planners and the executers, modifications in the format to ensure appropriate transmission of the propositions of the policies to the teachers. The study recommends for suitable changes in the presentations of the 'activities' in the textbook in the light of researches on hands' on science teaching.

100 RYMALA, MATHEN (Dept. of Science & Humanities, Faculty of Engineering Avinashilingam University of Women **Coimbatore 641043).** ATTIITUDES AND OPINIONS OF STUDENTS ABOUT SCIENCE EDUCATIONAT HIGHER SECONDARY LEVEL IN SELECTED SCHOOLS IN COIMBATORE CITY.

"The whole of science is nothing more than a refinement of everyday thinking"

Albert Einstein

science education should create a sense of wonder among children as it unfolds the secrets of nature. A sense of wonder is not just something that takes science forward. It is what keeps the mind

vibrantly alive and geared to take on life's challenges. Science is very difficult to comprehend through rote learning. Experiments make it easier and more vivid and kindle the joy of learning in children. Experience, observation, reflection, formation of abstract concepts and testing in new situations are the keys to meaningful learning and scientific progress. A major hurdle faced by the youth today is the state of higher education. This frustrates them not only because it fails to prepare them to be employable in a competitive era but also to excite their minds. The course content should be geared to develop concepts rather than merely provide information for memorizing.

Today there is a high demand for science subjects at the higher secondary level as it is the platform for professional course admissions. But whether the syllabi and the method of teaching kindle the minds of students and develop a scientific tempo and instill an yearning for research to solve the problems of today like energy etc. the study gives the attitudes and opinions of students who opted science subjects at higher secondary levels in selected schools of Coimbatore city which is the educational hub of South India.

101 RAGES, JOHN (Puthuparambil House Kuttipala, Mukkam, Calicut, **Kerala-673602**): NATURE THE BUDDING SCIENTIST WITH HUMANITY

In every society and in every age aim of education is to develop good and useful citizens who positively contribute to the welfare and progress of the society. It appears that in the present time science education falls through its aim. Majority of the students, after matriculation, prefer to pursue education in science stream regardless of their aptitude and potentials. Survey among hundreds of these students from higher secondary and degree classes revealed that they opt for science mainly because it guarantees high salaried and reputed jobs. Though the existing science educational institutions in our country are excellent in training and tutoring to make students competent and contributing citizens, the youth are more influenced by popular electronic media which are strong enough to swerve student's attitude, taste, and meaning of life in different ways.

Developments in electronic media has led to knowledge The survey further brought out the fact that the students, having much concern over their career and future, are very practical minded and the campus atmosphere has turned very detached, objective and competitive. Students openly admitted that they make friendships and contacts, and keep manners, values and morals purely with business motives. Aesthetics is neglected, as literary and artistic creations are looked at as useless, arduous and time consuming. Reading is limited to the prescribed text books. Teachers and students do not 'know' each other; the class room interaction seldom breaks the boundary of syllabus. All these have adverse impact on the efficiency and quality of the professionals coming out of the schools/colleges, which necessitated the further training in soft skills and life skills to make them fit. Mental health of students is also affected; reported incidents show that students lack stress tolerance.

explosion that any amount of knowledge on any topic is easily available with a 'click'. As a result, the role of teachers as source of information is dwindled and they remain as inspiring force that motivates and guides the students to find, generate and experience knowledge. But, the complex and strenuous life of the modern time and the changed family situation have added further demands on teachers. Teachers have to give constructive and corrective emotional experience to students to make and maintain them efficient and creative. There is a need to empower the budding scientists with humanity in this ruthless competitive world. Open the gates of science to Include literature in the syllabus; let students think and discuss values, aim and meaning of life. Let dramas, stories, poems and biographies add quality of scientific spirits. Besides learning the theories and inventions of great scientists, the students should also understand and take in the social commitment and concern that motivated

102 RAI, AJEET KUMAR AND BAJPAI ANJALI (Lecturer Faculty of Education Banaras Hindu University **Varansi 221005):** STUDENTS UNDERSTANDING OF NATURE OF SCIENCE: AN EXPLORATION

The contemporary era of science education reform is embedded in the philosophy of citizenship education. Thus there is an increase in the advocacy for preparation of scientifically literate individuals through school science education. Scientific literacy from the perspective of citizenship education connotes an understanding of the nature of science along with the content knowledge in science. Recently there is a

regeneration of interest in students understanding of nature of science that is evident in many of the international science curriculum reform document and the policy document of education of various nations. Thus a universal agreement has evolved regarding the significance of understanding of nature of science in preparing individuals for citizenship education.

A paucity of research studies to nature of science and particularly with respect to school students prompted the initiation of the above mentioned study. The hypotheses for the present study was that students' science content knowledge correlates with their understanding of nature of science and that there exists a difference in male and female students understanding of nature of science. Correlation research design was used to assess class ten students understanding of nature of science, particularly in relation to their gender and in relation to their science achievement. The sample was selected following two stage random sampling technique from six different schools of Varanasi city all the school were affiliated to Central Board of Secondary Education (CBSE). A likert- type Nature of Science Scale (NOSS) was used to collect the data pertaining to students understanding of nature of science. The scale used has four subscales that represent the different aspects of the contemporarily accepted view about nature of science. The marks obtained, in science by the students; in their school examination was used as a measure of their science content knowledge.

The analysis performed on the data revealed that the students possessed different level of understanding on the different subscales of NOSS. The correlation coefficient showed a week positive correlation between the students understanding of nature of science and their marks obtained in school science examination. However, no significant difference was obtained between the mean scores of male and female students on Nature of Science Scale. The data thus revealed absence of any difference in understanding of nature of science based on gender.

Based on the result of the study it was concluded that the high school students lack in appropriate understanding of all the aspects of nature of science. Consequently it was suggested that there is a need for some curricular and instructional reforms that may help our school leaving students to better understand the different aspects of nature of science that are essential components of scientific literacy.

103 SUBBA, RAO Y.V. (COIMBATORE CITY TEACHERS ASSOCIATION ALL INDIA FEDERATION OF SCHOOL TEACHER'S ASSOCIATION G.O. MS. No.2335/B[1] (Affiliated to World Federation of Teachers Union Ramalingam Colony, **COIMBATORE-641043).** TEACHING OF SCIENCE IN SCHOOL

Even though science is taught general in earlier classes, it is divided as Chemistry, Physics and biology etc from the 6th standard and separate syllabus was followed since then. Even this was followed in the secondary schools strictly but separate teachers were not appointed in most of the schools, thousands of posts for teaching not only for science but also for other subjects, teacher were not appointed even now. This appears in almost all the press reports. Hence, deficiently is teaching science is glaring in almost all the schools under all managements.

The colonial education system, with some charge and modifications, the injuries caused are not cured and the expected democratic system of education is still far off. The globalsiation, liberalization and privatization beside the commendation from the very bottom of education, including the science education in schools, colleges and University. Many educationists still consider the learning in English as good and better than learning in the vernacular.

Beside this the policy makers and politicians in power are not bold enough and come forward, boldly to get the accepted recommendation of the commission appointed by the same state and central Government implemented even after 50-60 years. That too even after making education a concurrent subject. The fact still remains on paper. The recommendation of Dr. Kothzri commission 1966-67 allotting 6% of central budget towards education is still a dream.

To date that the allotment on education did not touch 5% of the Budget of the central Government. It was only below 3.5% so far. Beside that the Educational taxes (cess) collected by local Bodies Panchayats, Municipalities, Corporation in crores were diverted to other purposes without spending a rupee towards Education, as per the reports appeared in the adult press.

Further press reports reveal:

(a.) There are 32,000 schools without teachers
(b.) 1,50,000 school are left as single teacher schools, 69,335 schools with 25 children 1,70,838 school with 20-25 children.
(c.) 1,02,277 Ele. School with ONE CLASSROOM
(d.) The rate of two Teachers for teaching science in each school both in Upper Primary and secondary school thousand of teachers are to be appointed in almost all in school.

Government, Both centre and state Governments recently declared various schemes for eradicating outing illiteracy in the country which is considered as a failure and wastage of public funds and they are for propaganda for vote securing.

Upper primary school in Tamilnadu were provided with science kits for teaching science by the UNESCO in 1964-65 irrespective of the fact, whether qualifies teachers are available or not. Mostly they were left as show pieces on exhibitions in the HM rooms. Latter Government introduced neighburhore several system which was found impractical for various reasons and dropped

104 SONAWANE V.C. And MANE VIJAY AEES (Homi Bhabha Centre for Science Education Tata institute of Fundamental Research Mankhurd **Mumbai- 400088 India).** EVOLVING NEW DEMOCRATIC SYSTEM REFLECTING PEOPLES: DEMOCRATIC NEEDS, ASPIRATIONS AND CREATIVE URGES

India was often called a snake charmer's country by the westerners. This was because a lot of superstitions beliefs were followed blindly. Today India has evolved itself as a major scientific community. Dr. Homi Bhabha, Dr. APJ Abdul kalam and many such scientists have proved that they are far ahead in the field of science than many other developing and developed countries. In the education institutes as well as in research organization, the main objectives of science education should be to create scientific temperament among the students, to develop logical thinking, but we often finds that very few students ask questions related to any physical or chemical processes stirring in nature. There is a unusual involvement of educated as well as uneducated people around us. Finally the question arises that are the educational objectives fulfilled in true sense?

No, not at all Indian scientific community today is in a dilemma as to which direction to go. There are thousands of illogical superstitious beliefs. Scientific community is under bureaucratic control both in and outside the system, lack of inherent scientific imagination and confidence, apathy to experimentation, love for science there are lots of obstacles like getting material in time for proper experimentation. We find lots of scientific development a greed for undue fringe benefits, loss of self-confidence...

Education of science should be open to all, in reality this is not the case. As Indian population is scattered and based on socioeconomic factors there is no doubt that a limited chunk of society (elite) is getting the benefits of developments in science and technology. Rural children are always deprived of scientific developments compared to urban, irrespective of their caste and religion. Comparatively the poor children are hardly focused on science education. This paper will focus on the major issues, hindering the quality of science education like; electricity, food, medical services, information of the rural and urban population who are far from the progress of scientific development who have not received the fruits of scientific progress as a whole

105 UMASHANKAR, PERIODI And RUDRES, S. (Azim Premji foundation, 134,Doddakannelli, Next to WIPRO Corporate Office Sarjapur Road, **Banglaore 560034,** Tel: +91-80-66144900/01/02 Board). CELEBRATING SCIENCE: THE SCIENCE MELA

"The process of preparation for the Science Mela has encouraged children to raise question in an informal and friendly atmosphere. I am sure that this culture of question will encourage a spirit of enquiry among children, which will be expressed within the classroom as well'"

Arathi, Assistant Teacher, Higher Primary School, Sathyampete

Science Meals are part of the Child Friendly School Program, a joint initiative of Government of Karnataka and Azim Premji Foundation. The Child Friendly School Initiative (CFSI) is an experiment (Started in 2004 in Shorapur block of Yadagir educational district of North-East Karnataka) to demonstrate a process of providing quality education, in a sustained and child-friendly manner. This is done in partnership with all stakeholders, by building capacity and accountability in the system, and the initiative covers all the 336 government primary schools of the shorapur block. In order to achieve its objectives, the program interventions deal with issues deal with issues within the classroom, school as well as community. In school interventions provide support to curriculum implementation, the teacher, the teaching-learning process, and improvement of the school and classroom environment, further, the program seeks to support a positive school-community interface, so as to ensure effective involvement and participation of the community. In this connection, the first Science Mela ever conducted was organized on 3 December 2008 at the Government Higher Primary School, Sathyampete. It had the following December 2008 at Government Higher Primary School, Sathyampete. It had following

We present here a report of this mela, wherein around 2500 children, teachers and community members participated. It had nearly 70 stalls and exhibitions pertaining to service, we describe the critical aspects of the mela, (starting from the preparation stage) analyses its impact by linking observables to the above objectives and above all, brings out how such a mela offers a way of using science as more than just one more subject to learn, demanding as it did participation by the entire rural community. As a paper that is being presented under the head: Envolving New Democratic System of Education Reflecting People' Democratic Needs, aspirations and creative Urges, we report here how the mela drew out of the School Development Monitoring Committee (SDMC), parents, teacher of various schools and their principals a sense of camaraderie and togetherness that true learning (in any subject) should nature. Interestingly, the mela, by its very design, emphasized clearly the process of learning science over a mere absorption (and recall) of facts.

1X- MATHMETAICS EDUCATION

106 BANERJEE, RAKHI (Centre for Studies in Sociology of Education, School of Social Sciences, Tata Institute of Social Sciences, Deonar, **Mumbai 400088).** BALANCING BETWEEN QUALITY AND EQUITY IN MATHEMATICS EDUCATION.

Deliberations for past many decades in the area of teaching and learning of school mathematics have raised more questions and issues than answered them. One can find difference of opinion with respect to mathematics that should be taught at various grade levels, how it should be taught, whether the mathematics should focus on utilitarian aspects or abstract mathematics for higher learning. Different societies are likely to value different goals, resulting in a slightly different choice of mathematics which is to be taught to children. Although there is no harm in enculturing children to what is valued in the community, decisions must be taken with care and caution. Adequate attention must be paid while formulating the curriculum so that the mathematics taught does not become disadvantageous to a section of the people. Granting that India is a huge country with large variations and that school education is valued by a large section of the population, for the benefits it accrues to its subscribers; it is even more difficult to maintain a balance between children's everyday experiences and communicating the essence, power, ways and means of mathematics. There is a challenge in designing a curriculum which have different starting points but takes the students to similar end points with certain minimal standards after some years of schooling. The similarity in the end points is not merely in skills of computations and fixed problems to solve, but developing similar repertoire of tools and techniques, attitudes and beliefs about utility of mathematics etc.

The dangers of both approaches, (i) oversimplifying content of mathematics and connecting it with everyday life leading to very functional mathematics learning, and (ii) a very content intensive mathematics with emphasis on definitions, concepts and symbols, cannot be ignored. On either extreme, the child will not be able to participate in the future endeavours, like higher education, professional courses and work life, which have both intellectual and material gains. It is this dilemma which I would like to address in this presentation. My own belief is that it is essential to draw children's ideas in the classroom and build the foundations of mathematics on that. But it should be able to emancipate the child from the concrete, practical experiences of everyday situation and take him/ her to more abstract realizations of properties and uses of mathematics. Usually, this is not possible without schooling and can be considered to be a function of schooling. I will focus on previous and contemporary research literature to throw light on issues of access to quality mathematics education and meaning making, and the concomitant goal of equity. I will also try to draw out some suggestions for improving mathematics teaching and learning in our schools.

107 MASKI, N.D. (Bhilai Steel Plant. Senior Secondary School Sector-6, **Bhilai, Dist. Durg. Chhatisgarh).** TRIGONAMETRICAL RATIO METER.

Mathematics is a compulsory subject upto the secondary level education. The pattern of teaching Mathematics is quite uninteresting today.

Due to latest researches, different new topics have been included in the syllabus. Therefore, teaching has been become very difficult. To make the teaching easy & interesting the use of communication method (i.e. audio-visual method) are seems to be very essential. So we have developed easiest technique based on DO AND LEARN method for Trigonometry thought Teaching aid Known as "TRIGONAMETRICAL RATIO METER"

In this method students are said to construct a right triangle with the help of thread and asked them to measure all sides. Again the interior of triangle is divided into two or three similar right triangles as

shown in given fig. Now all corresponding sides are measured and then the ratio of two corresponding sides is found out as shown here.

108 RAJU, C. K. (Centre for Studies in Civilizations, and Inmantec, **New Delhi).** CALCULS WITHOUT LIMITS.

1. This course teaches calculus using a new pedagogy based on a new history and philosophy of mathematics.
2. Currently calculus is taught[1] with limits. However, limits cannot be taught without teaching formal set theory and formal real numbers, and this is too complicated to teach at the school level. Hence, limits are typically postponed to a course on advanced calculus[2] or mathematical analysis[3] (which would still typically omit the requisite axiomatic set theory, [4] as distinct from naive set theory[5]). Thus, most students remain in a confused state after a course on calculus.

   They learn $d/dx\ e^x = e^x$ without learning either the definition of e^x or how to calculate it, because calculating it requires understanding the meaning of an infinite sum, and that requires limits which cannot be taught at an elementary level. However, it is considered important to teach calculus techniques to school children.
3. The student is typically drilled in symbolic manipulation skills which have become largely irrelevant over the last two decades, with the easy availability of symbolic manipulation programs like MACSYMA (now open source) or MATHEMATICA which any child can use to solve, in a fraction of a second, the most advanced symbolic manipulation problems in any calculus text. Thus the student lacks conceptual clarity, and learns little of practical value.

4. The basic need for limits arises from the current philosophy of formal mathematics, a philosophy developed by Russell, Hilbert etc, in the previous century. Formal mathematics is divorced from the empirical—hence it is purely metaphysical, and a social construct.[6] This metaphysics is not secular (or culturally neutral). Mathematical proof assumes two-valued logic, which is not universal—e.g., Buddhist, Jain, and quantum logics are not two-valued.[7] Theorems change with the logic used. Therefore, many theorems of formal mathematics would fail with Buddhist logic. That is, the theorems of formal mathematics are cultural truths, not eternal truths, as they are made out to be. The usual inflated epistemic claims are better understood sociologically by reference to the underlying religious beliefs.[8]

5. Against this background, the idea is to use a secular philosophy of mathematics[9] which focuses on the practical value of mathematics. One aspect of this philosophy is zeroism very similar to Buddhist sunyavada.

6. Although zeroism relates to Buddhist sunyavada, it is here advocated solely for its practical value.[10] Buddhist thought is widely understood to deny the existence of the soul, therefore in representing an individual it must tackle the problem of representing a constantly changing entity, which has no "essence" or constant part. Zeroism is, roughly speaking, a realistic (and anti-idealistic) philosophy of "approximate" representation—except that the very possibility of "exact" or ideal representation (and supertasks) is denied as erroneous. This philosophy of "approximate representation" can be usefully applied in mathematics, to do calculus without limits. Zeroism also suits the idea of mathematics as concerning practical computation rather than necessary or eternal truths.

7. The reason why zeroism makes calculus so much easier to teach and learn is that it retraces the historical development of the subject, or uses the principle that "phylogeny is ontogeny". Enough evidence exists to show that the calculus developed in India, over a thousand-year period, in response to the material needs of (1) monsoon driven agriculture and (2) navigation needed for overseas trade. It was imported into Europe by Cochin-based Jesuits in the 16th c., in connection with the European navigational problem, and diffused in Europe through Mercator, Clavius, Tycho Brahe, Kepler, Cavalieri, Fermat, Pascal, etc.11 Although recognized as practically useful,

the imported system did not fit into the epistemic understanding of mathematics in Europe. This led to enormous confusion about the calculus for centuries in Europe. Teaching calculus with limits reproduces this historical confusion in the classroom.

8. The calculus started in India as a shockingly easy and accurate technique to calculate trigonometric values (Aryabhata 5th c.) equivalent to Euler's method of solving ordinary differential equations (ODEs). [12] Just as zeroism replaces limits; this numerical technique of solving ODEs replaces the "fundamental theorem of calculus". This numerical technique is very easy to understand and implement, especially by using computers.

9. Thus, on "phylogeny is ontogeny", we propose to teach calculus as primarily concerned with the ("approximate", numerical) solution of (implicit) ODEs. This is very easy to teach, and has several decided advantages over conventional calculus courses which teach symbolic manipulation without full understanding—a mechanical task better performed by computer programme such as MAXIMA. This new approach teaches the practice, and can be immediately applied to solve "hard" problems in Newtonian physics. Actual course modules, and related software (CALCODE) have already been developed, but will be adapted with ongoing field trials.

109 SULE, ANIKET And SULE, KALPANA P. (G. N. Khalsa College, Mumbai, HBCSE, Mumbai). VANISHING ART OF MENTAL MATHEMATICS

Ability to perform simple arithmetic calculation mentally is a useful art in our daily lives. However, it is observed that more and more percentage of students rely on pen and paper (in lower classes) or, even worse, calculators (in higher classes) to do such trivial calculations. We wish to present a sample study exploring co-relation between proficiency in mental mathematics and general mathematical ability of students. The sample consists of class 8th and 9th students from urban elite schools and is complimented by teacher / parent responses on the role of mental mathematics in mathematics education.

X- COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

110 AGRAWALLA, RAMAN KUMAR (Bussiness Systems and Cybernetics Centre, Tata Contsultancy Services, 5-9-62, 6th, Floor Khan Latif Khan Estate Fateh Maidan Road, **Hyderabad-500001,** Andhra Pradesh India, **Tel: 66671679).** NATIONAL DEVELOPMENT THROUGH IT-ENABLED FUNCTIONAL EDUCATION.

The primary ingredient of any nation's development is education of its people In India, 'education for all' has been an essential element of our national development strategy but yet a great deal needs to be done and achieved in this direction. After reviewing the current status of 'education for all' in India, the present paper suggests a new approach to education i.e. IT-enabled *Functional* Education. The emphasis is to educate functionally and not necessarily formally that part of India's child population who are not in schools and not going to schools for myriad of stated or unstated reasons. Our approach attempts to put the child and her/his needs in the educational centre-stage. The paper demonstrates how the innumerable advantages of the Information and Communication Technology can be exploited to impart functional education successfully to 'select child population'. The vision is to realize that IT-enabled Functional Education permeates the entire school education in India. The highlight of our work, is describe a process to help assimilate the target children mass to achieve the desirable dream of 'education for all' in India leading to its total development.

111 DHAKULKAR, AMIT AND NAGARJUNA G. (Research Scholar Homi Bhabha Centre for science Education Tata Institute of Fundamental Research V.N. Purav Marg, Mankhurd **Mumbai-400088). GRAPHING THE WORLD.**

The use of graphs to teach science at school level is under utilized. In this work we want to present an approach to address this problem. We want to teach graphing skills to the students, that will enable and empower them to explore, analyze and interpret the physical world around them. We want to provide the school children with cheap electronic and computer based platforms for this purpose. The use of computers with cheap ease the collection and display of data, thus leaving more time for the analysis. A variety of sensor elements will be needed for this purpose. Some of the examples would include light, temperature, humidity, distance and magnetic sensors. Along with these sensors we need to provided appropriate instructional activities and software to observe and analyze the data. We want the students to be able to make, read and analyze graphics; we want to make them graphically literate.

Both the software and hardware used for this purpose should be free and open source {FOSS}. We have two such platforms in mind for this purpose. Phoenix is a versatile tool which provides the users with analog and digital input/output capabilities {http:// www.iuac.res.in/ elab/phoenix/}. Phoenix allows you to develop science experiments by connecting sensor and control elements to a computer and access, analyze the data through. The other platform that we are looking forward to is the OLPC {One Laptop Per Child} {http://www.laptop.org}. We are developing activities for OLPC which would enhance science learning. We are also working to integrate the OLPC with Phoenix. The progress and problems in this work are reported here.

112 KUMAR, V. SASI (Free Software Foundation of India Space, Thiruvendrapuram). IT- ENABLED EDUCATION IN SCIENCE.

Today's age is known for the advancements in and popularity of Information Technology (IT). There is hardly any aspect of our lives that has remained unaffected by this technological revolution. However, education remains one of the few areas where IT has not made much impact. Schools in many

Indian states are not required to teach IT in spite of the fact that most students currently in schools are very likely to have to deal with IT in their adult lives. When considering the fact that IT is a very rapidly changing technology, we realise that there cannot be delay in introducing IT to students. But, apart from being a subject of study, IT is also a powerful technology that can be effectively used for teaching and learning. At the same time, what is being taught in many schools is just to write programme in one or more languages. C, C++ and Java are the most popular. All this has to be carefully reconsidered and redesigned for achieving the best results.

This paper attempts to look at the possibilities of IT-enabled education in science in detail. However, let us also review the kind of IT education that is provided in most schools in the country. Interestingly, the training that most schools try to give children is to write programme, an activity that only a very small fraction of computer users indulge in. Yet, only very few school curricula provide for training in using popular applications like a word processor, a spreadsheet or a web browser. While it is certainly good that children learn the basics of programming, it is not at all desirable that children do so at the cost of being ignorant of doing simple tasks on a computer. Further, even if it is found desirable to teach children programming skills rather than the ability to use an email client, the choice of programming languages leaves much to be desired. C and C++ are certainly not the kind of languages that are the most suited for an introductory course in programming. One could think of Logo as a good language to introduce programming with, and some schools do use it. At the same time, a powerful language like Python would be much more comfortable for a beginner compared to C or C++.

At the same time, there remains the possibility of using IT for more effective classroom transactions especially in subjects where abstract ideas have to be transacted, as in, say, Mathematics. This is certainly not a call to replace the blackboard and chalk with a computer screen or the teacher with an animated character. There are still teachers who can transact difficult topics very effectively in a classroom without anything more than a blackboard and chalk. But, we cannot expect every teacher to be capable of doing that. So, we have to tune our education system with the average student and average teacher in our mind.

In this context, it may be worthwhile to point out the Kerala was possibly the first state in the country to make IT education a compulsory part of high school, with IT included as a subject in the SSLC examination. About five lakh students have been taking the examination in IT every year as part of their SSLC examination. It had been decided that the state would move towards IT-enabled education from the present academic year. But this did not happen. We hope it happens by the next academic year. The idea is that children should acquire IT skills while learning all subjects with the help of IT. This becomes relevant when we consider that IT is a tool for doing almost anything, empowering people, while it also remains a technology domain that provides high paid jobs.

We can hardly ignore the relevance of Information Technology in school education. At the same time, it appears that it would be beneficial to introduce the constructivist paradigm as suggested by NCERT. On the other hand, most schools in the country are already suffering from lack of sufficient facilities, and this situation is bound to raise questions of the relevance of introducing computers when other basic facilities do not exist in schools. But it is not correct to ignore IT because other facilities are important. One thing that is clear is that only Free Software can be used in schools. Even if the ideological reasons are ignored, which cannot be done in an educational context, we see that the costs would become double or more if proprietary systems are adopted. There are lessons that can be learned from the experience of Kerala, but they should be adapted to the conditions in each region rather than just copied.

113 SINGH, KULBIR BATH, KANT, RAMA Project Assistant, POS Division Punjab State Council for Science & Technology, MGSIPA Complex, Sector 26, **Chandigarh – INDIA):** POPULARIZATION OF SCIENCE AND TECHNOLOGY IN PUNJAB

There is no alternative to Science & Technology for Socio-economic Development. The Punjab State Council for Science & Technology (PSCST) since its inception in 1983, has been serving as a focal point for planning, promoting and carrying S&T activities and acting as a Nodal Agency for Science & Technology. Various initiatives have been taken up by the Council to improve science education in Punjab and to inculcate scientific temper amongst the students, teachers and the general public of the state through

various means such as, setting up science city, science centres, rural science corners, conducting short- term and long term programmes, publications etc. This paper

presents an over all scenario of initiatives taken up PSCST for popularization of science in Punjab.

114 TAPATI, BASU AND PRAMANIK, GOPA (Dept. of Journalism& Mass Communication C.U. **Kolkata 700073**). CYBER CRIME- A BURNING ISSUE OF DIGITAL NETWORK.

The potential of the Internet to facilitate crime is increasingly a matter for public concern. This has given rise to a need to understand and measure cyber crime. However, attempting to quantify the amount of cyber crime is not straightforward. It is clear that cyber crime is a pressing and prevalent social problem. As access to the Internet has grown then the opportunities for the commission of cyber crimes have increased. As more individuals access the Internet, the cyber criminal has a broader range of potential victims within reach. Moreover, the increased availability of personal information online provides the identity thief with useful portfolio of identity information as a 'starter kit' for the misuse of that identity. That is not to say that the Internet has spawned a whole new set of crimes. For instance, 'identity theft' is not a criminal offence in itself, but could give rise to liability under the Information Technology Act, 2000.

The Internet has, however, made the commission of what might be termed 'traditional' crimes easier –or more widespread. A further example relates to child pornography. Distribution of child pornography is a criminal offence, which was relatively well contained prior to the Internet: it is now a widespread social harm. Moreover, the nature of the Internet, and its relative anonymity enables individuals to behave in ways that they would consider to be unthinkable in the physical world.

It has been suggested that the moral boundaries relating to technology are at odds with the moral standards of the physical world. In essence, the lack of tangibility in the technological realm suggests that the ethical considerations relating to personal property and privacy in the physical world do not apply in the electronic world. This allows people to engage in deviant behavior involving computer misuse whereas they would be less likely to engage in the analogous physical world mischief. Moreover, computer misusers tend not to consider their actions as immoral. This lack of virtual moral consensus has been referred to as 'toxic disinhibition': arising from the very nature of the interaction of the individual with the technology. Individuals are led into a relationship with technology within which conventional moral rules and norms do not apply. This paper tries to establish those things in the context of Indian perspective. Moreover it will be depicted partially a view of cyber crime occurred in India and abroad.

115 VARMA, LAL BAHADUR (B-239, Chandra Shekhar Nagar Telearganj, Allahabad 211004): WHY, WHAT AND HOW OF HISTORY

People have to know and realize, and must feel pride in it, that it is they who are makers of history and not the so-called heroes whose biography history has been projected to be.

In a world in which people are getting more and more involved in to-days and to-morrows who should be bothered about yesterdays and why—more so when it is supposed to be dead? First, because to-days don't hang in the vacuum and are rooted in yesterdays and whatever we do to-day and dream for to-morrow—good and bad, are shaped by whatever was done by us or by our ancestors yesterday.

Why is knowing about the past so necessary? Because we cannot understand the present without referring to the past. Introspection and retrospection are the two pillars of epistemology and retrospection is the historical method.

But when one cannot know, even superficially, the present one lives in, it would not be difficult to imagine how impossible it is to know, much less understand, the past in its entirety. So history can be about only that past which according to French historian Marros, is known and knowable, to which humans society can relate.

Then, how to know about the universal and relevant past? That requires an authentic, accepted and recognized historical method which may not make history a science, nothing less, nothing more, as British Thinker A.B. Bury wanted it to be, but it can make history scientific nevertheless—more credible and acceptable and useful.

People are in reality more different than divided but rulers that be, want to keep them more divided bull-dozing pluralities. Peoples' history can turn the Table Topsy-Turvy on anything and anyone anti-people, only if it is proposed and practiced genuinely.

X11- HISTORY AND PHILOSOPHY

116 DHAKULKAR, AMIT AND NAGARJUNA G. (Homi Bhabha Centre for Science Education, Mumbai 400088). AN INVITATION TO PHILOSOPHY OF SCIENCE.

Generally it is found that the science teachers do not have a sufficient background in the history and philosophy of science. In this article we consider an approach to history and philosophy of science {HPS}, which would be immediately relevant to school and college teachers, and other philosophy students. It is an attempt to factor what every science teacher ought to know in history and philosophy of science. We plan to have a graduate course at HBCSE with aim of bringing out material from HPS in form of a booklet for teachers. The course structure would be woven around episodes from history of science, which would highlight an issue in HPS. We hope that the use of historical episodes from science would lead to better participation from teachers and students. Some of the episodes that we have identified for this purpose include Euclid's fifth postulate Archimedes' experiments, establishing roundness of the earth, the heliocentric model, Darwin's concept of evolution. The aim of this paper is to invite constructive criticism of the designed curriculum for improvement.

117 KHARATMAL MEENA AND NAGARJUNA, G. (Homi Bhabha Centre for Science Education TIFR, V.N. Purav Marg. Mankhurd **Mumbai-400088**). REFNED CONCEPT MAP FOR MAPPING THE HISTORY OF SCIENCE.

Refined concept Map (RCM) is a concept map that uses minimal and least ambiguous set of relations names consistently to represent a body of knowledge. RCM is development over the concept maps in terms of applying a minimal set of relation names. Focusing on the nature of relation names enables to represent scientific knowledge in rigorous manner. It is widely known that in biological domain, there are thousands of concepts. On the contrary, the relation names that are used to create relations between concepts would be a fixed and a minimal set. A part of our research study also deals with to identify such a set required to represent the entire domain of cell biology from school, college and undergraduate level.

In this paper, we are highlighting the above claim of depicting the minimal set of relation names for the domain of cell biology. We are applying the refined concept map for analyzing the scientific knowledge depicted in the domain of cell biology at three level---8,9,11 standard textbooks. A comparative study is being carried out wherein we are representing the textbook knowledge using the refined concept map. The domain is "Cell structure and Function" of standards 8, 9, 11. we have represented the same domain for all the three standards and found that although the number of concepts goes on increasing the number of relation names is a fixed and a minimal set. This set comprise of upto 15 relation names only for the entire domain at all the 3 standard. While there are 70 concepts standard 8; 195 concepts in standard 9; 500 concepts in standard 11, the number of relation names are only 15 that are used in all the 8,9,11 standard are: consists- of; includes; surrounded by; composed of; has function; has attribute. Further we are also analyzing the number of relation names, kinds of relation names, number of concepts linked to relation names, frequency of relation names, etc. and shall be reported in detail.

In addition to the above, we shall highlight the Refined Concept Mapping as a methodology, its efficacy to bring in precision in the representation of knowledge, its use in pedagogy, and its feasibility for school students.

118 KUMAR, RAJESH (Institute of Mining & Fuel Research P.O. FRI, **Dhanbad-828108**, **Jharkhand**). SOME CRITICAL OBSERVATION OF SCIENCE EDUCATION IN INDIA.

What we see as such education is for every one. There is lot of primary Schools, Middle Schools, High Schools, intermediate Schools, Graduate and Post Graduate Colleges and Universities. There are

incentives for children to attend school like mid day meal scheme. There is free education for female children up to certain age. There is concessions in fee for schedule Caste and Schedule Tribe students. There is scholarship system for poor students. Government employees get reimbursed the tution fee of their wards. This is a small list of facilities for boosting education among the people, there are many more things. Despite this all, all are not educated. Those who wants to study science can not take science as their subject. After studing science there is no employment for every one. But some are getting employments, award, and fellowship etc. Where faults lie for such problems. I have seen some of the things which pinches me and thinking if my father or other near relatives would have holding a higher position in universities or any scientific institution centairly. I would have also had a good position by this time but alas! This could not happen with me. I had to struggle from very beginning for small things. Then I am thinking luck is a important thing. But luck and relation with a high position person alone can not provide fortune in life. Determination is important for making life fortunate and prosperous. Hurdles come but may be disappeared if there is strong will for doing a high thing in society. This is one part, other part is teachers have become businessman. They sale education, bargain for tution fee. Teacher are less teaching in school, spending more time in their homes for tuting the children and making money from teaching business. Teacher have become corrupt, this is not applicable for all teachers. Still some teachers are very good, they have love for their students and they devote full time for educating their students.

119 KULKARNI, JAGDISH CHANDRA K. ( )वैज्ञानिक विकास की आवश्यकता

120 LOKKU, DOJI SAMSON (Tata Consultancy Services, 06th Floor, KLK Estate, Nampally, **Hyderabad 500001**). CRITICALITY OF KNOWING KNOWLEDGE FOR EDUCATION IN SERVICE ECONOMY.

The title of the proposed paper refers to the need perceived by the authors for unearthing some thing that is seemingly fundamental about the very entity called knowledge. It refers to the context of the use of knowledge in this age of service economy.

Education is largely about imparting knowledge, Education is for life. One of the many things that can have a bearing on our lives is the economy we live in. keeping in the view the change that has come upon us from product economy to service economy, what changes in education will prepare a person for life?

The erstwhile product economy has made use of knowledge to produce goods, but in service economy, the produce or goods are taken for granted. The uniqueness about service economy is that knowledge itself gets transacted directly as part of human endeavour. It is no longer about the transaction of knowledge based entities as in product economy but of the very knowledge itself. Though knowledge underlies every economy, perhaps it is the service economy where in knowledge has been greatly exemplified to such an extent that it is even dubbed as knowledge economy.

Unlike the produce or goods, what is the shape or form of a service? Product economy predominantly dealt with entities of a specific form or shape, where as in service economy formlessness is the norm. Since it is knowledge that is being directly transacted as part of providing a service, how much we know of this very entity called knowledge so that it translates to a services with desirable quality characteristics? How does this influence education, which is about imparting knowledge?

Education, either it is Science or Math or Technology, all of it is being made use of to design, develop and deliver produce or goods. In this sense the product economy has greatly been benefited by the knowledge that has been imparted as part of education thus far. But when it comes to services, development and delivery of a service happens on the fly. Moreover, unlike products, services fall under one time production category.

Similar to product solutions, even solutions that address societal concerns are built over a period of time. What are these solution made of? What technologies can we make use of to develop or build such

solutions? How do we archited and engineer such solutions in the first place, in order for them to be realized successfully over a period of time, for the cause of society?

The proposed paper is oriented towards the fundamental research that may be undertaken in future with respect to the entity called "knowledge" and attempts to describe some of the features/challenges that are associated with it. Education thus far has enabled so much human endeavour and it is the author's hope that it can accomplish much more if the fundamentals of knowledge are unearthed.

121 MASHOOD, K.K. AND NAGARJUNA G. (Homi Bhabha Centre for science Education TIFR, V.N. Purav Marg. Mankhurd **Mumbai-400088**). LEGACY OF EINSTEIN: SUBTLE INTERPLAY OF PHYSICS AND PHILOSOPHY.

What is attempted in this paper is a brief elucidation of some of the aspects in the intellectual evolution of Albert Einstein —— one of the greatest scientists of all times. In Particular, emphasis is laid on in bringing forth clearly the role of philosophy in the making of the scientist in Einstein. A biographical analysis starting from early childhood reveals the presence of a philosophical bent of mind which has been significantly substantiated by philosophical reading in his youth. The books that were read in the friend circle 'Olympia Academy' bears evidence for this. It would not be too farfetched if one states that philosophy played a crucial role in the genesis of the revolutionary scientific contributions of Einstein. The schools of philosophies which influenced Einstein's thoughts at various points are looked at. At times the influence of philosophy on his physics was explicit, instances of which are discussed in the paper. The viewpoints which the scientist himself maintained on various topics of philosophical interests like the method of theoretical physics, scientific and religious truth etc are also given a brief look. At a time when physics education involves no substantial involvement with philosophical issues, it is hoped that a biographical analysis of this sort would provoke a pedagogical rethinking. The current crisis of creative dearth in the subject can be attributed at least partially to practices like ignoring engagement with philosophy, which in the past triggered the metaphysical curiosity of many great masters in the subject. Often it was this curiosity which motivated many brilliant minds to traverse the otherwise dreary and long path of scientific inquiry. Life of Einstein provides a clear illustration of the constructive role philosophy can play in science education.

122 MITTAL, ASHOK KUMAR (Department of Physics, University of Allahabad). SCIENCE EDUCATION: ANALYSIS FORM DIFFERENT PERSPECTIVES.

Goals of education in general and science education in particular, from the perspective of humanity, the country, the educationists and the students are analyzed.

The overt and covert goals of science education in India are examined. The weaknesses and strengths of this system are discussed. The effects of this system on different types of people and the country as a whole are analyzed. Some of the root causes for perpetuation of weaknesses in the system are identified and methods for overcoming these weaknesses are suggested.

Value neutral nature of science is emphasized. It is argued that science education without value education is extremely dangerous. In the absence of sensible values, science empowers people to corner resources, increases disparity and divides people. It alienates people from society and nature.

Values are divided into two categories: Primary and Secondary. It is highlighted that science cannot prescribe primary values. It cannot tell us what our goals should be. Thus primary values have to be inculcated as part of value education that must supplement science education.. Secondary values are those values, which though not an end in themselves, are considered essential for achieving primary values. For example, wanting to be happy may be regarded as a primary value. We may believe that the more money we have the happier we are likely to be. Therefore money becomes a secondary value. However, the role of money in making people happy can be subject to scientific enquiry. Individuals and societies tend to become slaves of secondary values while losing sight of primary values. 'Competition' has become one of

the more dominant secondary values of modern societies, which it is believed is essential for achieving the primary value of human happiness and welfare. The extent to which this belief is valid, can be explored through scientific enquiry.

Science education that is fuelled by a competitive society is contrasted against science education that nurtures intrinsically worthwhile scientific attitudes. Modern competitive societies are based on the assumption that competition accelerates scientific progress and fosters excellence by automatically diverting all resources including human intellectual resources towards the most worthwhile pursuits. This assumption is analyzed critically.

An attempt is made to analyze whether scientific progress has emerged more from intrinsic human curiosity without care for reward, or more from individual, institutional and corporate greed. Examples are given of how reward orientation adversely affects scientific temper and has made science an instrument that has endangered humanity in several ways from global warming to biological and nuclear warfare.

Finally, it is concluded that science education is a subsystem of the human society. It is inevitable that it will reflect the values and the mind set of the larger society. Yet this subsystem is also instrumental in creating values for the larger society. So science education must endeavor to teach people to use science for satisfying the needs of all the people. It should not fuel endless narrow competitive greed in individuals, institutions, corporate and nations.

123 M. RAJENDRAN (Project Fellow, UGC- SAP, The M.S. University of Vadodara **390002).** RELEVANCE OF HISTORY AND PHILOSOPHY OF SCIENCE FOR SCIENCE CLASSROOMS.

As a rapidly developing nation, India needs urgently large number of human resource for all its sectors, so that it can provide better quality of life to its citizens. At the same time in the competitive world, science and technology driving the development of any nation, Indian science education needs to develop original thinkers, innovators, researchers to accomplish this task. This demands that we need to have institutions which can foster the culture of inquiry in science classroom from the school level to higher education level. But our education system fails to do it and discouraging the students to raise questions in classroom during teaching learning process. This is because still our science classroom activities is relying more on repetition and memorization. The emphasis is still on amount of content student memorized than he / she understood. This makes the student feel science is an abstract and difficult subject. The growth of knowledge demands that student to acquire new knowledge. Therefore, we need to have a curriculum which can accommodate the required amount of content coverage as well as concept understanding. The history of curriculum change also suggests the same.

In this context, teaching science through historical and philosophical perspective will help students to understand the science better. History and philosophy of science (HPS) is both 'knowledge about science' and 'knowledge in science' emphasized for better learning. Despite the intensive discussions that have been conducted over more than a hundred years since this idea was first articulated, HPS has seldom been implemented. This indicates the complexity and controversial nature of the issue, and the necessity to invest theoretical efforts to its comprehensive analysis. So, it is important to discuss the arguments favor and against in incorporating HPS in science teaching which will help to develop a new strategy for improving science teaching learning in school and higher education.

124 NAIR, T.P. SANKARANKUTTY (Ex. Director, Institute of Kerala Studies, Sree Sankaracharya University P.R.A G-58, G.P.O Lane, **Trivandrum – 695001).** SCIENCE EDUCATION IN KERALA – THE ROLE OF P.T.BHASKARA PANIKKER (1921 – 1997).

Suchen, Versuchen, Untersuchen" is the motto of science. This German usage means, "to seek, to experiment and to investigate". Scientists should not subscribe to superstitions. They should not have blind

belief or blind disbelief in anything. The scientist is not obstinate or stubborn. He is ever ready to admit his mistakes and to rectify it when he realizes the full truth.

Science and technology have helped a lot to improve the conditions of modern man. It affords new material facilities. It provides man with greater leisure and pleasure. It eradicates diseases. It dispels superstition. It helps to remove or control social ills. It raises the standard of man's culture and civilization and many more are the benefits of modern science. According to Dostoevsky the very notion of perfection is outside the purview of science and that there is gap between the notion of perfection and the impossibility of attaining it. We can only cultivate a scientific temper throughout our life. This will create a dynamic view of life. This is however not easy to observe or implement. Nowadays we find the scientific attitude disappearing under the new stresses and strains of a crisis ridden society. The boldness in conceptualization, the freedom of thought, the tolerance of diverse views and the healthy skepticism which are the essential features of a scientific attitude were lost. The progress or advancement of science in India is possible only if we restore the above essential features.

The present paper is an attempt to assess the role of P.T.BHASKARA PANIKKER (15-10-1921 TO 30-12-1997) who was individually responsible for showering scientific sense, temper and attitude in the minds of Keralites. In early sixties of the last century PTB after his Malabar District Board President ship (1955-57) and Kerala Public Service Commission Membership devoted his time and energy to inject the scientific sense and founded a Sastra Sahitya Samiti in Ottapalam in the Pallakkad district of Kerala. Persons like P.K.Koru Master played a part in this. But soon it died out. The same motto instigated Dr.K.G.Adiyodi, Professor of Kozhikode University to establish the Sastra Sahitya Parishad founded by the first Jnanpith Award winner of India, Prof.G.Sankara Kurup. PTB along with M.N.Subramoniam, Prof.C.K.Moosad, Dr.A.Achuthan and others strengthened Sastra Sahitya Parishad. Although Dr.Adiyodi was the prime mover, it was PTB who proved to be the brain behind all activities of the Parishad in Kerala which organized Village Samities to conduct science classes. In 1970 the aim was to conduct one thousand classes on science, religion and culture but it conducted more than five thousand classes all over the state. It was a postcard revolution of PTB who used post cards to direct the science class movement all over Kerala. Hundreds of schools/colleges/university teachers rallied round PTB for this scientific social revolution in Kerala without any ready money. Prof.M.K.Pasad, U.K.Gopalan, Dr.Vijay Madhavan, Dr.M.P.Parameswaran, Dr.B.Iqbal etc joined the Sastra Sahitya Movement by the time it became a mass movement. When it brought out a scientific social revolution the Communist party realized that their disassociation with it was a blunder. This led to a call for large scale party involvement in the advancement of Sastra Sahitya Parishad. When it was made a red organization it gets enough money and more party members. Non party members including PTB disassociated with it. Eureka, Sastra Keralam, Sastragati and Primary Teacher are four magazines or weeklies started by PTB to popularize science in Kerala in the vernacular. The way PTB led science jathas added not a little for the spread of science and technology in Kerala. This savant has not been given proper recognition by KSSP today. The science movement in India and for that matter science education could be realized from kindergarten level. There is no meaning in injecting science temper/ sense among grownups. This change is the need of the hour. In recent days science popularization suffered a lot under orthodox hands. Religion is not against science. Science religion and culture should go together to bring properity.

125 PARTHASARATHY, R. (No. 42 1st Street, "Heverlee' Ram Nagar Vijaya Nagar Velachery **Chennai 600042**): SCIENCE EDUCATION WITHOUT HISTORY: AREFLECTION:

Since 1950, Students seek first admission to engineering courses inprefrence to pure science, because there is parental pressure or little social acceptance for the science courses.

Homi Bhabha opened the door to show the kind of opportunities available by creating in 1945 and unique institution in the country. In my teaching career in IIT Madras, students showed delight in my lectures such as in acoustics, tunnel diode, radio propagation.

Sir C.V. Raman hailed him as the modern equivalent of Leonardo da Vinci.

During the prime time of my career (1973-75), I was required to obtain the doctorate degree: it was a challenge, when I was passing through penury.

The passion for science, determination to work against odds that I read in the lives of the great men of science such as Lenwenhoek, Descrates, Weirstrass and Van Der Waals (school teachers), Faraday and Maxwell, S.N. Bose, Acharya P.C. Ray, Ramanujan and C.V. Raman stirred up creative urges in me and showed me the path.

In my D.I..I Sc. (1945-48) at the I.I.Sc. Bangalore, I could at the young age of 19, perceive the deficiency in the prestigious course: no lecturer in the Department of Electrical technology to teach Modern Physics or Mathematical Analysis on which engineering rests. But I derived inspiration from my Alma mater.

I heard no lectures in Maxwell's Field Equations, quantum Electronics, and Statistical Theory. I paid dearly for it in my career by catching up new field which I had not even heard, on my own preparation. IIT Madras accorded recognition of my research work on Continued Fraction Techniques in Model Reduction by awarding research degrees to my students (Ph. D and M.S.)

126 RAJENDRAN M. (Project Fellow, UGC- SAP, Department of Education, The M.S. University of Baroda Vadodara – 390 002). RELEVANCE OF HISTORY AND PHILOSOPHY OF SCIENCE FOR SCIENCE CLASSROOM.

As a rapidly developing nation, India needs urgently large number of human resource for all its sectors, so that it can provide better quality of life to its citizens. At the same time in the competitive world, science and technology driving the development of any nation, Indian science education needs to develop original thinkers, innovators, researchers to accomplish this task. This demands that we need to have institutions which can foster the culture of inquiry in science classroom from the school level to higher education level. But our education system fails to do it and discouraging the students to raise questions in classroom during teaching learning process. This is because still our science classroom activities is relying more on repetition and memorization. The emphasis is still on amount of content student memorized than he / she understood. This makes the student feel science is an abstract and difficult subject. The growth of knowledge demands that student to acquire new knowledge. Therefore, we need to have a curriculum which can accommodate the required amount of content coverage as well as concept understanding. The history of curriculum change also suggests the same.

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127 RAJENDU, S. (Post Graduate Teacher, Sree Valluvanad Vidya Bhavan Sr. Sec. School, Post-Eravimangalam, **Perintlamanna 679322, Malappuram -Dist., Kerala).** AN INSPIRING AND STIRRING LIFE OF A RURAL PRAGMATIC TO THE SCIENCE EDUCATORS AND YOUNG FLAIRS.

P.T. Bhaskara Panicker, pragmatically a visionary and predominant to the educational and scientific movements, played a key role in shaping village science activities that kindled modern thinking

in basic science in Kerala. Many studies about him are revealed so far, but this is the first attempt to summarize his science-related activities intact in English.

PTB was engaged in many activities and movements. But this study focuses on his liveliness in the science world. Many materials and notes are available on him; including his books and his forward and preface to other books were referenced for this preparation. I have used the Study-Analyze-Extract-Write (SAEW) method for preparing this paper.

The first were social reformers and activists who saw in science a useful ally in their struggle against the outmoded past. Secondly, there were science writers who were mainly concerned with their professional problems and saw in the organization a means to redress them. The Kerala Sastra Sahithya Parishad at its time of formation at Kozhikode in 1962 was more in the nature of a professional organization of science writers.

PTB pointed out that it was necessary to build up one science centre in each district. These centers are the ideal place to improve the science education and related activities. He started Indira Priyadarshini Science Education Center in Venganoor. This center arranged many activity oriented science classes, seminars, workshops, exhibitions, rallies and study tours.

The Social Action group for Science, Technology and humanity in Rural Areas (SASTRA) is an organization to encourage village science education, technological development and humanity. Many leading activists attended the inaugural meeting. PTB wrote the rules and regulations of the organization. Ezhom of Kannur district is the centre of the organization. The primary aim of SASTRA was to build ovens with the help of another organization called ANERT. For fulfilling this aim, workshops for labourers or clay moulders were conducted.

In June 1977, KANFED (Kerala Association for Non-Formal Education and Development) was registered under the Travancore-Cochin Charitable Societies Act No 12 of 1955 as an offshoot of Kerala Grandhasala Sanghom and Kerala State Library Council, comprising the members of the Literacy Expert Committee of the Sanghom. KANFED had before it certain specific objectives:

to eradicate illiteracy from the state
to provide opportunities for continuing education for all people in need
to strengthen the non-formal mode of education
to link development activities with non-formal education

There are two kinds of academic discourses in India: one accepts and perpetuates the agenda of the West, while the other tries to alter and resist it according to our own needs; one is colonized, the other is anticolonial; one modern, the other is traditional; one is Euro centric the other indigent; and so on. To deny the internal struggle in Indian academics between two such discourses, to pretend that all of us belong to the same discourse, or worse, to claim that only one discourse exists in fact, is to shut out dialogue.[3] Many influential political leaders (Gandhi for example) who had renounced the more superstitious religious beliefs, in favour of less superstitious beliefs also contributed to the mainstream western perspective on India remaining a status quo. He (PTB) was one of the best of the best example to do so and his activities are the best among any civilized reformations and its message was the conversation beyond all limits.

128 TIWARI VISHWA MOHAN (Air-vice Marshal (Rtd) E-143, Sector 21 Noida-201301). क्या हिन्दू पौराणिक उपाख्यानों से विज्ञान शिक्षा मिल सकती है .

यह शीर्षक विरोधात्मक लग सकता है–विज्ञान की बातें और वे भी पौराणिक उपाख्यानों से! इस संदर्भ में हमें सत्रहवीं शती के प्रसिद्ध वैज्ञानिक गालिलेओ की घटना याद आती है। टॉलैमी ने सौर मंडल की संरचना की

एक अवधारण प्रस्तुत की थी कि इस सौरमंडल का केन्द्र पृथ्वी है तथा सूर्य सहित अन्य ग्रह, वास्तव में समस्त ब्रह्माण्ड पृथ्वी की प्ररिक्रमा करते हैं। यह अवधारणा बहुत लोक प्रिय सिद्ध क्योंकि यह बाइबिल की इस संबंध की अवधारणाओं से मेल खाती थी। कोपरनिकस ने गणितीय सिद्धान्तों तथा ऑकड़ों से सिद्ध किया कि सूर्य सौरमंडल का केन्द्र है। गैलेलियों ने इस सिद्धान्त का जब तेजी से प्रचार किया तब मार्च 1616 में कार्डिनल बैल्ललार मीने ने एक आज्ञप्ति जारी की जिसके अनुसार गालिलेओं कोपरनिकस की अवधारण को न तो स्वीकार कर सकता था और न उसका बचाव कर सकता था। 1624 में गालिलेओं 1616 की आज्ञप्ति को रद्द करवाने के लिए रोम गए। वह आज्ञप्ति रद्द तो नहीं हुई किन्तु पोप ने उन्हें दो शर्तो पर सौरमंडल की दोनों– टौलैमी की तथा कोपरनिकस की–अवधारणाओं पर लिखने की अनुमति दी। एक शर्त थी कि गालिलेओं इन दोनों अवधारणाओं पर निरपेक्ष रहेंगे। दूसरे वे निष्कर्ष निकालेंगें कि, 'मनुष्य सर्वशक्तिमान ईश्वर द्वारा विश्व निर्माण की प्रक्रिया को जानने के लिए अतिक्षुद्र प्राणी है।' बस, पोप को कट्टरपंथियों द्वारा समझाया गया कि चर्च की पारम्परिक शिक्षा पर यह पुस्तक लूथर तथा काल्विन दोनों के संयुक्त प्रहार से भी अधिक चोट कर सकती है। 62 वर्ष की आयु में बीमार गालिलेओ को अपना घर (फ्लौरैन्स के निकट) छोड़कर रोम आना पड़ा। एक समिति ने उन्हें दोषी घोषित किया और जेल में कैद की सजा दी, क्योंकि उन्होंने कोपरनिकस की अवधारण को मान्यता दी थी और उस पर शिक्षा भी दी। और उनसे कहा गया कि वे अपनी उस मान्यता को नकारें। गालिलेओं ने अपनी तथाकथित पुरानी गलतियों के लिए पश्चाताप किया और अपनी मान्यता को त्यागा। तब कहीं पोप ने उनके जेल के दण्ड को 'गृह कैद' में बदला। गालिलेओं ने तो यह अपमानदायक दण्ड भुगता, स्वयं कोपरनिकस ने अपनी खोजपरक अवधारणा को अनेक वर्षों तक गुप्त रखा था। उन्होनें उसे मुत्यु के दो वर्ष पूर्व ही प्रकाशित किया था। गालिलेओ, कहना चाहिए, भाग्यवान थे, पश्चाताप करने के बाद मात्र 'गृह–कैद में रहे। टाइको ब्राहे (1546–1601) को अरस्तु–टौलैमी की खगोल अवधारणाओं को वैज्ञानिक आधार पर गलत सिद्ध करने के अपराध में अपनी जागीर से बहिष्कृत किया गया था। जर्दानों ब्रूनों (1548–1603) ने कोपरनिकस की अवधारण को सत्य मानते हुए, उसका प्रचार किया, तथा 'रिवलेशन' या इहलाम को अंधविश्वास कहा। इसके कारण उन पर चर्च ने मुकदमा चलाया तथा दण्ड स्वरूप उनका जीवित दाह–कुसंस्कार किया गया।

XIII- LANGUAGE OF SCIENCE EDUCATION

129 BHARGAVA, VIJAY KUMAR (F-6/1 Sector –7 Vashi Navi Mumbai- 400703) : विज्ञान एवं तकनीकी शिक्षा का माध्यम स्वभाषा क्यों और कैसे'

स्वतंत्रता की आधी से अधिक सदी बीत जाने के बाद भी यह विवाद का विषय बना हुआ है कि विज्ञान एवं तकनीकी शिक्षा का माध्यम स्वभाषा हों या नहीं। कोठारी आयोग की संस्तुति 'स्नातकोत्तर शिक्षा भी मातृभाषा में देना कठिन नहीं है' के बावजूद यह कहकर अंग्रेजी को बनाए रखा गया कि स्वभाषा में उच्च स्तर की शिक्षा देना संभव नहीं है। इस का कारण यह रहा कि एक ओर तो सत्ताधारी वैज्ञानिकों एवं शिक्षकों द्वारा राष्ट्र के विकसित होने की दृष्टि से इस विषय पर चिंतन नहीं हुआ और दूसरी ओर विभिन्न संस्थाओं द्वारा स्वभाषा के प्रचार प्रसार को केवल साहित्य के विकास एवं बोलने तक सीमित रखा गया। तीसरा सबसे बड़ा कारण इन सत्ताधारी वैज्ञानिकों की कथनी व करनी में अंतर रहा है। इस विषय पर राष्ट्र को विकसित बनाने की दृष्टि से चिंतन करने की आवश्यकता है। इस आलेख में विकसित राष्ट्र की परिभाषा दे कर चर्चा की गई है कि उसकी आवश्यकताओं की पूर्ति के लिए विज्ञान एवं तकनीकी शिक्षा का माध्यम स्वभाषा ही क्यों उपयुक्त है और कैसे संभव है। विकसित राष्ट्र का अर्थ है वह राष्ट्र जो स्वाभिमानी हो, मानसिक गुलामी से मुक्त हो, सम्पन्न हो, आत्मनिर्भर हो, जहाँ जन जन की खुशहाली हो, और जहाँ प्रतिभाओं का पूर्ण रूपेण सदुपयोग हो। स्वाभिमान तब पनपता है जब हम "स्व" पर अभिमान करें जैसे स्वभाषा, स्वदेशी इत्यादि। विश्व में सम्मानित भाषा पर ही अभिमान हो सकता है। कोई भी भाषा सम्मानित तब होती है जब वह उच्च स्तर के ज्ञान विज्ञान की वाहक हो, केवल बोलने वाली भाषा सम्मान प्राप्त नहीं कर सकती। कोई भी भाषा ज्ञान विज्ञान की वाहक तब बनती है जब वह उच्च से उच्च शिक्षा एवं शोध लेखन का माध्यम हो जाए। सम्पन्नता, आत्मनिर्भरता और जन जन की खुशहाली वैज्ञानिक शोध एवं देश के अनुकूल प्रौद्योगिकी के विकास पर निर्भर करती है। इसके लिए मौलिक चिंतन,एवं शोध लेखन के लिए भाषा पर अधिकार की आवश्यकता है। यह मनोवैज्ञानिक मान्यता है कि मौलिक चिंतन कम से कम प्राथमिक शिक्षा स्वभाषा /जनभाषा में प्राप्त करने से ही संभव है। इसका कारण यह है कि मानव जिस भाषा में सपनों की उड़ान करता है उसी भाषा में मौलिक चिंतन संभव है। विदेशी भाषा से हम ज्ञान तो ले सकते हैं पर ज्ञान का सृजन नहीं कर सकते और ज्ञान के सृजन से ही देश सम्पन्न होता है। राष्ट्र के विकास में स्वभाषा माध्यम से पढ़ी हुई एवं महाविद्यालय में नहीं जा सकने वाली प्रतिभा का योगदान के लिए स्वभाषा में शोध एवं जन जन की भागीदारी के लिए स्वभाषा में लोकप्रिय विज्ञान उपलब्ध कराना आवश्यक है। यह लोकप्रिय विज्ञान या तो सीधे वैज्ञानिकों द्वारा लिखा जा सकता है या साहित्यकारों द्वारा। दोनों ही स्थिति में मौलिक लेखन आवश्यक है जो उच्च वैज्ञानिक तकनीकी शिक्षा स्वभाषा में होने से ही संभव है। आलेख के अंत में चर्चा की गई है कि शिक्षा का माध्यम स्वभाषा कैसे किया जाए।

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130 JAJODIA, SHARMILA (Department of English Ramniranjan Jhunjhunwala College Ghatkopar (West)-**400086 Mumbai-India):** INSIGHTS INTO INTERRELATION OF LINGUISTICS AND THE OTHER SCIENCE

The title of my paper is "Insights into Interrelation of Linguistics and the Other Sciences".

Language, a cognitive system in its varied forms and manifestations, is the most sophisticated and versatile means of communication and therefore, is part and parcel of human existence. This has been realized by educationists as well as scientists from various branches --sociologists, anthropologists, neurologists,

psychologists, philosophers, speech therapists, communication engineers etc. Hence (re) searches into various fields are carried out to understand and ease the language acquisition process.

All normal children are mostly exposed to language at an early age and acquire normal language development. Historically, theorists and researchers have emphasized that nature and nurture i.e. biology and environment play a crucial role in language acquisition. While traditional behaviourists claim that language is learnt through imitation, practice, feedback on success and habit formation, Chomskyan innatists hold that children are biologically programmed, have specific language abilities (LAD) that facilitate and constrain language learning. Some theories and researches strongly suggest the essence of 'critical period' CP) and 'interaction' in language acquisition but detractors of these claims believe that language learning aptitude is more important otherwise perfect second language acquisition is perhaps not possible. Therefore, linguists focus on the similarities and differences in first and second language learning. While psycholinguists trace the relationship between language and mind concentrating on acquisition, storage and loss of language, neurolinguists study language deficit caused by specific forms of brain damage. On the one hand, sociolinguists are concerned with language use, its variation, development, change and standardization, its various dialects, lingua franca etc. ethnolingiusts, on the other hand, unstudied language in distant and primitive culture due to modern technological and Industrial advancement. Similarly, philosophic enquiries involve exact reasoning and minute examination of the meaning of words and of the relations between sentences as language is the fundamental tool for preservation and dissemination of all organised knowledge. Communication engineers have set themselves the task of transmission of speech, its conversion into signals and re-conversion into written messages. Recently, its most progressive branch computational linguistics deals with the use of advanced computer techniques to further linguistic research and problem solving.

Thus linguistics and the other sciences are intimately bonded owing to the research areas in common and can't be divorced at any cost. The insights gained through the current researches in the various branches of linguistics and related sciences help each other and are applied to make language learning and teaching effective and efficient process. Now the hotly debated issues within the purview of research are- whether the methodology and pedagogy of language acquisition has transformed due to the sci-tech advancement and (re) searches in the related sciences; whether first language acquisition differs from second language acquisition; how do or how much these (re) searches assist to acquire and teach a language to normal and differently abled children? Etc.

In the light of these concerns, this paper is directed to explicate the mutual relationships between linguistics and other sciences to have a better insight into language acquisition process.

131M. RAJENDRAN AND MADHAVI R.L. (Lecturer Department of Education The M.S. University of Vadodara **Vadodara 390002).** ROLE OF LANGUAGE IN SCIENCE EDUCATION.

Language is an important tool for communication. It is learnt from the surroundings, from a formal institution. Language is a dynamic entity that undergoes constant change in structure and spoken form with the times. As a result we find many dialects for the same language. For each purpose of expression, the language nature is different. For example, the script writing for radio and television are different to get desired effect according to the media used. In education also depending on the purpose the expression of language is different. For Arts and Social Sciences the language that needs to be used is specific and so is same for the subject of Science. Here the expression of subject matter is more important than aesthetic sense of language. Particularly related to science subject, the expression of language needs to be more terse, compact and specific, as the subject matter is dealing with universal facts. This capacity is to be there in the person who is teaching science and also in the person who is learning science. But for a country like India, where multilingualism characterizes the education process, the way of providing science education using a single language is not proper to achieve the goals of science education. Because of lack of support from home front child may not be in a position to grasp the concepts when not taught in his mother tongue. Special care need to be taken to sustain child's interest in both language and science to achieve the goals of science education to full extent. The present paper is focusing on some such aspects.

132 MANE, SUDHAKAR RAHUL (Centre for Studies in Science Policy, J.L Nehru University, **New Delhi).** LANGUAGE OF SCIENCE EDUCATION

Science education is increasingly subject to the capability to adapt English language to understand the objective approaches of basic sciences. Vernacular languages struggle to achieve comprehensive space in science pedagogy because of lack of updated science-technology publishing even in academic circles. Challenges of original creativity in mother tounge are directly derived from progress of scientific culture and widely respected institutions in the country.

This situation ultimately poses us in peculiar situation where development in scientific research is increasingly hostage to the development of researcher in English language skills. This remains to be proved that it may be one of the reasons we could not invent innovative ideas in fundamental research in early age which might be possible by promotion of scientific education in vernacular language.

This is not to argue that we should totally ban English language in science education. Our cognitive frame of reference revolves in the circle of imagination drawn by mother tounge. By maintaing the formal interaction about developments about technology in English language, it is quite possible to establish curriculum of fundamental science in the vernacular languages. One can argue that the simultaneous and parallel education of scientific principles in vernacular and English language may create disharmony in the learning process of science but I believe to explore about the possibilities to enhance the intuitive talent of the students who are at secondary and higher secondary level.

Wish to show that the argument about doubtful disharmony to be created in theoretical and practical understanding of basic scientific principles by introduction of both language media is unwarranted. He want to demonstrate the capability of the secondary students by allowing himself to interact with them to develop a combined orientation about the possibility of vernacular science education strengthening the discerning capability of rational attitudes reflected in ethos of scientific enterprise.

Expressive power of students learning in secondary and higher secondary schools need to be empowered in order to develop the interactive skills of the students with scientists, teachers and other experts of that field. This interactive capability will be more easy to arrive at if aspect of mother tounge is considered seriously and implemented according in the framework of curriculum. The conscious efforts in this direction demand the creation of separate institution devoted to massive translation of original research from English to vernacular languages and also to train the emerging vernacular language postgraduate students who are willing to enter in the profession of education. This initiative of creating massive institutional framework demands the urgent attention of education thinkers, administrators, policy makers and most importantly the teaching community.

133 MALLIKARJUN, B. (Central institute of Indian Languages, Manasganjosi **Mysore 570006).** COMMUNICATION SCIENCE THROUGH TEXTBOOKS

The makers of the Constitution of India made a special provision in the Constitution for development of selected Indian language to become vehicles of modern science by including them in the Eights schedule. The onus of implementing this clause of the Constitution is with the Department of Education, Govt. of India. The Govt. of India has established the Commission for Scientific and Technical Terminology (CSTT) to provide standard technical terms in Science and Technology to be used for communicating science in the country. As a result, volumes of technical terminology have been created. But the technical terminology thus produced, to a large extent are not in use in the textbooks. The Supreme Court has taken a serious note of this in its judgment.

Science communication in India takes place at four level: Writing on Popular Science in the media as well as booklets etc, for popularizing science: Production of Reference materials on science like science encyclopedia which form basic reference tools for students, common man, researcher etc., Publication of original research papers on scientific research and last but not the least Science text books used at various stages of education in the schools, colleges etc. most crucial stage of education in secondary education i.e., from 8^{th} to 10^{th} standards. In order to analyze the use of technical terminology, sentence

pattern and their communicability, study of Physics and Chemistry part of the 10th standard text books in both Kannada and English Medium were compared and contrasted. The 10th standard Kannada Science textbook is a translation of the science text book written in English. While translating various information get added in the Kannada version and at the same time various items get deleted in Kannada while coming from English. Many a times this along with other features make Kannada text book non-communicative or partially communicative.

This paper analyses the communicability of 10th standard Kannada Science Text Books used in Karnataka

134 PATHAK, PRAVEEN and SINGH, VIJAY A. (Homi Bhabha Centre for Science EducationTIFR V.N. Purav Marg, Mankhurd, **Mumbai- 400088).** LANGUAGE OF INSTRUCTION AND MISCONCEPTIONS IN PHYSICS: A BILLINGUAL SURVEY

India is a vast country with a multilingual culture. Almost every state has its own board of education which deals with school education. It is believed that student's knowledge level depends on socio economic background and method, mode and language of instruction. The present study attempts to address the issue of effectiveness of medium of instruction in developing content knowledge.

We have prepared a small but carefully designed inventory of multiple-choice questions to probe students' understanding of the role of friction in rolling bodies. The Friction in Rolling Bodies Inventory (FRBI) was prepared after consulting a host of text books and references. The content validation of FRBI was done by an independent group of experts in the field.

We then studied the students' to response to our FRBI. The students were from a variety of backgrounds and from different parts of the country. The first group of students were from non-metropolitan background and had English as the medium of instruction (Group I). the second group of students came from the same non-metropolitan background and had English as the medium of instruction (Group II). Both group had same the same syllabi and were governed by the same board of education. We covered five distinct non-metropolitan areas: Kanpur Dehat and Saharanpur (both Uttar Pradesh), Sagar and Hatta (both Madhya Pradesh) and Varodara (Gujarat). The students were administered the inventory in their language of instruction (English, Hindi and Gujarati). Results indicate that both group of students perform similarly on the inventory. Our study is admittedly limited in scope but it appears that medium of instruction does not significantly affect content knowledge.

135 SINGH, NARENDER PAL AND PANDEY A.K. AND SINGH AWADESH (286-, Paramanatpur **Jaunpur-222002),** SOME LINGUISTIC UNSEEN SCENES IN SCIENCE EDUCATION.

Science and technology have extended their arms over all the activities in the universe leaving no space in education. The scientific approach to the subjects and the technological methodologies to inject the concepts of the subject matter into the minds of the students are becoming very common in countries like India. But unfortunately, there are innumerable discrepancies, missing and misconnects in units, dimensions, definitions, notations, obbreviations, modeling and modulation in learning science, technology and the allied branches.

In the present presentation an effort has been made to search out such holes in science education and some fruitful effective means have been suggested to fill up and rectify them.

X1V- NEW SYSTEM OF SCIENCE COMMUNICATION

136 BEHERA S.M. (Janapriya vighyan Manch E.B. – 499 Badaganda BRIT Colony **Bhubaneswar–751018).**TIPSON SCIENCE AND TECHNOLOGY OMMUNICATION.

"Emphasis on the need of Science & Technology Communication in Various language is the cry of the present day, because, it can able to create maximum, desired impact in the society & common man in particular for their sustainable development. Therefore, a true Science Communicator must remember the Science of Scientific Writings. A few tips in that connection are cited as a token of reference.

. If the reader is to grasp what the writer means, the writer must understand what the reader needs.
. Information is interpreted more easily and more uniformly if it is placed where most readers expect to find it.
. Beginning with the exciting material and ending with a lack of luster, often leaves us disappointed& destroys our sense of momentum.
. The information that begins sentences establishes, for the reader a perspective for viewing the sentence as a unit.
. Put in the topic position the old information that links backward; put in the stress position the new information you want the reader to emphasize
. As Critical scientific readers, we would like to concentrate our energy on whether the experiments prove the hypotheses.
. It may seem obvious that a scientific document is incomplete without the interpretation of the writer, it may not be so obvious that the document can not 'exist' without the interpretation of each reader (Ref. : American Scientist Non-Dec 1990 Volume-78,550-558).

Further, Science Communications should also have introspections on the following points before they write on any topic. These are:-

(1) Be aware of different languages.
(2) Hook the reader.
(3) Avoid scaring the reader off.
(4) Use analogies wisely
(5) Be rigorous.
(6) Aim at the target
(7) Avoid formulae.
(8) Use humour.
(9) Avoid Jargon.
(10) Put complex concepts in a box.
(11) Do not encourage false hopes.
(12) Give the reader a break by writing short paragraphs.
(13) Give illustrations where ever you can.
(14) Caption the actual image.
(15) Put Scientoon concept at the end of the article.
(16) Include other perspectives on the issue under discussion.

137 BORA, ABHIJIT (Dept. of Communication& Journalism Gauhati University, **Guwahati 781014).** MASS MEDIA AND SCIENCE COMMUNICATION: AN INSIGHT.

India possesses the largest pool of people formally qualified in various science and technology subjects of study in the world. Yet we do suffer from a general lack of a scientific temperament or attitude while dealing with all the problems in our life. The lacunae may be at several levels – our education policy, its implementation, avenues or media for spreading informal education to the majority of the people in this field etc. In this paper we are trying to analyze and look at the scope of utilizing the services of the immensely potential weapon of mass communication and media for popularizing science education and creation of awareness of a scientific attitude amongst the masses in an exhaustive manner. We are throwing light on various efforts taken up so far, possibility of using well-established and proven mass media experiments for this purpose, problems encountered while implementing such a policy, the issue of addressing the vast majority of people beyond the reach and capacity of the formal educational system of the country among others. This is because we firmly believe that science and technology as well as communication and mass communication are essentially interdisciplinary vocations of our life which (when combined) have the power to transform our lives to a high degree of improvement. The only question is how to do so or implement the project for practically achieving this goal in the short and long term as well.

We are trying to develop a synergy between these two extremely-important necessities of our lives so that all the latest scientific developments taking place in the highly-sophisticated laboratories of the world can actually deliver the goods for public welfare – the ultimate goal of all such endeavours anywhere in the world. We are looking at the possibilities of involving the communities in the process of disseminating useful information for the benefit of the members of the same communities, encouraging community-based media which are conducted and run by the specific community of which they are a part of, problems and prospects of very widespread bigger mass media compared to smaller more personal media including folk and traditional media etc. The goal is to find out a judicious media planning for making the campaign a success while also looking at creating an adequate bank of learning materials and resources as repositories of knowledge for the purpose. In the process we also discuss the role of the government, the society, the educational institutions, mass media in carrying forward the sacred goal of creating an awareness about a scientific temperament and awareness for the general masses of the country as a whole. Even though we can't say that we have succeeded in showing a specific way for achieving the goal yet we will feel successful if we could have initiated serious debates and discussions in the society among the people concerned in the right direction for arriving at a better solution for the purpose.

138 Bose. Arvindam, Sharma Amit And Mishra Krishna Kumar (होमी भाभा विज्ञान □ाक्षा केन्द्र, टाटा मूलभूत अनुसंधान केन्द्र, वी0एन0पी0 मार्ग, मानखुर्द, मुबंई 400088) समाचारपत्रों में सूर्यग्रहणः एक भौक्षिक वि□लेशण।

आज के इस विज्ञान तथा तकनीकी के युग में विज्ञान संचार का क्षेत्र बहुत व्यापक हो गया हैं विज्ञान संचार तथा विज्ञान लोकप्रियकरण को विज्ञान एवम् प्रौद्योगिकी की एक विशिष्ट शाखा के रूप में मान्यता दी जाने लगी है। जनमानस में वैज्ञानिक दृष्टिकोण का विकास हमारे संविधान के मूल कर्त्यव्यों में से एक हैं ऐसे में जनभाषा में जनसंचार माध्यमों के जरिए संविधान तथा राष्ट्रीय विज्ञान–नीति की मूल भावना का आदर करते हुए लोगों में वैज्ञानिक चेतना तथा विज्ञान–साक्षरता विकसित करने का अहम उद्देश्य पूरा किया जा सकता हैं विज्ञान संचार, खास करके, लोकविाान की मूल भावना लोकहितकारी है। वास्तव में विज्ञान संचार वह कुंजी है जो जनोपयोगी ज्ञान–विज्ञान की जानकारी तथा वैज्ञानिक दृष्टिकोण के लाभों को जनता तक पहुंचा सकती है जो उन्हें विज्ञान तथा प्रौद्योगिकी के क्षेत्र में हो रहे विकास के प्रति जागरूक बना सकती है ताकि वे रोजमर्रा के जीवन की समस्याओं का बेहतर ढंग से सामना करने में सक्षम हो सकें।

विगत 22 जुलाई 2009 को घटित इक्कीसवीं के विश्व के सबसे बड़ें पूर्ण सूर्यग्रहण को समाचार–पत्रों ने जिस तरह से लिया तथा जगह दी, यह परचा उन्हीं प्रेक्षणों तथा विश्लेषणों पर आधारित है। इस अध्ययन में मुंबई से प्रकाशित तीन भाषाओं (हिन्दी, अंग्रेजी तथा मराठी) के कुल 8 अखबारों का चयन किया गया तथा 19 से 23 जुलाई 2009 तक 5 दिनों के दौरान समाचारपत्रों ने सूर्यग्रहण के कवरेज को मद्देनजर रखा गया। अध्ययन में पाया गया कि किसी भी अखबार ने इतनी बड़ी खगोलीय घटना पर संपादकीय लिखने का कष्ट नहीं किया। समाचारपत्रों में इस घटना को काफी स्थान दिया लेकिन प्रकाशित सामग्रियों में ज्यादातर या भेंटवार्ता प्रकाशित नहीं की, जिसमें ग्रहण की वैज्ञानिक व्याख्या तथा उसका विश्लेषण हो, जबकि ऐसा पूर्णरूपेण अपेक्षित था। ग्रहण से जुड़े शैक्षिक संदर्भों का स्पष्ट अभाव अखबारों में साफ नजर आया जबकि लोक सशक्तीकरण की दृष्टि से इन विविध आयामों की चर्चा नितांत जरूरी थी। हॉ, ग्रहण से जुड़ी रूढ़ियों तथा मिथों पर ज्यादा जोर था तथा इस अद्भुत ब्रह्माण्डीय घटना को कमोबेश पूजोपासना के एक अवसर के रूप में दे देखा गया। ग्रहण से जुड़ी वैज्ञानिक तथा वस्तुनिष्ठ बातों पर जोर कम था, तथा घटना को विज्ञानसम्मत नजरिये से देखने की कमी साफ दृष्टिगोचर हुई।

139 DAS, AMLAN KUMAR (Dept. of Chemistry Sikkim Manipal Institute of Technology Majitar, Rangpo **Sikkim (East) 737132).** HOSHANGABAD SCIENCE TECHONOLOGY PROGRAMME: A NOTE ON EVALUATION.

140 DESHMUKH, D. NARENDRA AGARKAR C. SUDHAKAR and OER4S PROJECT TEAM (Homi Bhabha Centre for Science Education,Tata Institute of Fundamental Research V. N. Purao Marg, Mankhurd, **Mumbai 400088).** DEVELOPMENT OFLEARNING OBJECTS OER4S PRJECT: OPPORTUNITIES AND SOME CHALLENGES.

The paper reports an initiative taken by a Homi Bhabha Centre for Science Education (HBCSE), Maharashtra Knowledge Corporation Limited (MKCL) and the Indian Consortium for Educational Transformation (I-CONSENT) to develop Open Educational Resources for Schools (OER4S). The goal is to develop a new paradigm of education for large numbers with connectedness for offering Quality School Education for All, and for sustainable development of local situations – classrooms, schools and local community - by linking them to global scenario. The mentioned project is being funded by the Rajiv Gandhi Science and Technology Commission of the Government of Maharashtra.

For the development of useful content five workshops were organised at Pune and Nagpur. More than 1000 modules were developed. The web-based resources were developed collaboratively by academicians, teachers and enthusiastic parents. They will be made available to the stakeholders (teachers, parents and students) through the distributed classrooms set up by the Maharashtra Knowledge Corporation Limited (MKCL). Recently, a five days workshop was arranged at Pune to develop 'Learning Objects' by using free confluence software under OER4S Project. The 35 participants for this workshop were drawn from practicing teachers, teacher educators, parents and subject experts.

The paper also describes constructivist approach taken for the development of both Course Blueprint and Learning Objects for Secondary Level School Science, Mathematics, Social Science and Environmental Science. This first LO Workshop, gave a rich experience in carrying out a "constructivist" OER Training in OER development. The Workshop was, according to one participant: "Generally, there is a lot of talk about constructivism. But this is the first time such training is being offered and material is getting developed." This workshop was carried out by Ram Takwale and other OER4S team member.

141 DUBEY, PAWAN KUMAR And GUPTA ANSHUL And MAZUMDAR ANWESH (Homi Bhabha Centre For Science Education Tata Institute of Fundamental Research Mankhurd, **Mumbai 400088).** SOLAR ELIPSE AND TELEVISION: A STUDY MADE TO LEARN THE CONTRADICTION OF ORTHODOX AND SCIENCTIFIC PROJECTION ON YOUNG MINDS.

Middle school students learn the phenomenon of eclipse in dual manner. Their idea about this wonderful astronomical event are primarilarly governed by science and geography studies but highly influenced by the predictions telecasted on television.. An On-site study was made on the total eclipse day (22nd July 2009) after the recording of pre-event telecast in different languages. It was found that the programme telecasted prior to the eclipse contributed negatively to the learning of young children. Since most part of the study was executed in the peripheral rural area of Mumbai, It reflects the eclipse understanding of an ordinary middle school student. The problem can be best encountered using physical model to make the children understand the phenomenon. Analysis also revealed that the schools where the teachers prepared for the eclipse a few days earlier, students responded more scientifically.

142 GANDHIMATHY, S. and NATARAJAN CHITRA (Homi Bhabha Centre for Science Education (TIFR), **Mumbai).** USING REAL-WORLD ISSUES TO PROMOTE ACQUISITION AND APPLICATION OF KNOWLEDGE AND SKILLS IN A DEMOCRATIC ENVIRONMENT.

Education continues to teach science, technology and social issues in isolation, leaving students to fend for themselves in dealing with real-life situations, which involve mesh of scientific, technological and social issues. This paper discusses the development and structure of an activity based book on food security, which facilitates the learning of the complex relationships between Science, Technology and Society (STS) in a democratic classroom environment.

Addressing largely post-school students, this is an unpublished book in a series of activity books published on STS issues including Global Climate Change, Energy, Health, Conflict and Ecological Balances.

The book is a collection of sequenced activities through chapters and sections. Each section deals with different issues that may be connected with other sections in the book or to activities in another book in the series. Together they provide a glimpse into the real-world complexities of STS issues. Each activity normally begins with probing questions about everyday experiences, which both encourage the development of observational skills and promote critical awareness about what is observed.

The book has a large variety of activities, requiring the participants to use a range of skills: recognizing patterns in tables and graphs, map reading, picture association, drawing, analyzing social and technological contexts, studying and interpreting historical works, surveys, problem solving, making inferences across space and time, leading a group/ project, debating, making presentations, etc. The paper provides examples of how engaging with real-life problems can promote interactions of students and participants with the larger society and help them develop social skills and acquire valuable life skills.

This book is an effort to fill a gap in the education system: to make education more relevant to real life. The book addresses post school students as it uses school level knowledge scientific and mathematical procedures and skills. Such books can provide meaningful activities to sensitize people of all ages on issues related to their natural and social environment.

143 GOVIND MADHAV (Centre for Studies in Science Policy, Jawaharlal Nehru University, **New Delhi, India).** Transmission of Knowledge and Skills in Academic Science: an Exploration in to Ph.D. training Programme in the Indian Universities.

The transmission of knowledge and skills during doctorate training occurs through a bi-lateral interaction process between the supervisor and the student. This interaction plays a significant role in affecting the quality of the student and his research out put as well as his prospect in academic career. The study is based on the qualitative data from 150 Ph.D. students enrolled in five research Universities: Jawaharlal Nehru University, Delhi University, Rajasthan University, Jaipur, Lucknow University and Indian Institute of Science, Bangalore, along with the supplementary data obtained from the intensive interview with 35 professors/supervisors located in these research institutions. The paper analyses the various processes through which students acquire knowledge and skills of the professional practice of research and scholarship.

The study reveals that a student is heavily dependent on his/her supervisor for motivation and guidance on formulation of research problem, selection of relevant literatures, interpretation of experimental data and finally communication of results in a peer reviewed journal. The doctorate students are expected to learn the key disciplinary norms governing the conception, production and reporting of knowledge in their particular discipline. Many of these disciplinary norms are not explicit and the researchers learn them by 'tacit' means during their interaction with the faculty and their peer group. During the process a student also develop 'soft skill' of cultivating local and global research network which are essential for the success in the academic career and in this process his /her supervisor plays very important role.

The study indicates institutional, cultural and disciplinary variations in the convention, norms and practices regarding the doctorate training and suggests the policy implication for the higher education in science.

144 HUNMA, VANDANA (Mauritius Examinations Syndicate **Mauritius).** SCHOOL SCIENCE EXAMINATION AND UNDERACHIEVEMENT.

"Some mute inglorious Milton here may rest Some Cromwell, guitless of his country's blood."

Thomas Gray (1750)

These two lines from the "Elegy Written in a Country Churchyard" by Thomas Gray draw our attention to the many talents that remained latent and thus unsung. His observations on underachievement remain equally valid even today and may be all the more pertinent as it would appear that underachievement is begin fostered by the formal education and examination system.

This paper founded on empirical research attempts to show how the current practices of school science, tailored mainly to produce 'good' examination results, provide a narrow and indistinct view of science that significant numbers of students at all ability levels fail to enjoy and make sense of. They 'retire hurt' either with poor self concept or use the widely accepted 'difficult' nature of science to sit back and not make adequate efforts to see the complete picture of science that is imperative to become efficient users of science. The main aim of learning science then becomes preparing for the examinations.

It is common knowledge that all objectives are amenable to external examinations. However, logistical constraints to communicate and explore the nature, methods and knowledge of science combined with a poor management structure to monitor and support what happens inside a classroom further affect the acquisition of some of the feasible objectives.

This paper raises certain pertinent questions regarding the limited view school science has come to assume and its inadvertent repercussions on students' learning and self esteem, highlights the need for a refocus to prevent the delivery of school science as a 'rhetoric of conclusions' for examination success and proposes some corrective measures.

145 JAYARAMAN, MYTHILI (City High School **Hyderabad**). THE NECESSITY OF SCIENCE EDUCATION IN SCHOOL.

146 JOGI, VEDAVATI RAVINDRA (Freelance Media Professional 5, Om-Tat-Sat Apt. 212/50, Rambaug Colony Navi Peth**, Pune 411030).** NEW DEMOCRATIC SYSTEM OF SCIENCE EDUCATION BY MENAS OF PARTICIPATORY VIDEO.

Utility of video as a medium of instruction has already been proved. Breaking away from the conventional path of producing educational video films for high school students with professional support, the researcher has tried to tap the spirit of innovation & creativity in students themselves to produce video clips for their own education. Thus tried to bring 'Balshahi' on the lines of 'Lokshahi' in the Education system.

Lokshahi or Democracy is a Political system run by the people for the people themselves in which one should get chance to show his merit and should get equal share in the development.

Even today in Indian schools, learning is by rote, education system is exam. Centric, and educational communication is a 'one way' affair. To develop new democratic system for Science education, Researcher conducted series of workshops for more than 100 students coming from Socio-Economically underprivileged community in which expert science teachers discussed certain important concepts in Science like, Newton's laws of Motion, law of Conservation of momentum, Covalent bonds, Nervous System etc. At the same time students were given exposure to video filmmaking techniques with low cost equipment. Then students as Creative Individuals developed their own films on those Science concepts.

Present paper discusses objectives, methodology, observations and some prima facie inferences that could be drawn from Observations and products i.e. video films created by students which throw light on,

1. How students develop cooperative working attitude as quality of the final product depends on each & every member's contribution given at each & every stage of production.
2. How grouping done according to skills give every student chance to show him merit.
3. How each & every stage of film production brings about qualitative change in participating student's personality as a Science student.

147 JOSHI ANANT KUMAR (District institute of Education Training Garhi Banswar **RAJASTHAN).** HEADING TOWARDS SCIENTIFIC INDIA NEW HORIZONS TO SCIENCE TEACHING.

The teaching of science in general is a challenge specially in treble belt of western Rajansthan where the impact of modern science is rare and avability of modern ways of teaching is still a big constrain. In this institute of south Rajasthan various models of teaching are used for updating the knowledge of primary & upper primary level school teachers and at the same timer providing them latest available teaching techniques for the students. The immediate teaching client of the new teaching methods are school teachers and ultimate beneficiaries are the students. On the basis of my 20 years experience several points emerged which need to be improvised as per need of the hour. In the present paper those aspects of pedagogue being discussed with a view to enhance the capability of science teachers and generate better science students.

The science education needs to be more specific and selective. It is also felt that the choice of the subject should be at ninth standard instead of present undergraduate level. It is also suggested that not more than two subject should be there out of which one should be main and the other subsidery. This will rise to

vertical expansion {general teaching}. Teacher should be proficient in practical so that their thoughts are also more competent. For achieving this the teachers should be given rigorous practical training by modifying exercise.

Services of trained and more skilled teachers should be utilized at upper primary level Establishment and essential visit of science park, science museum, science gallery etc should be given emphasis.

Writing pattern of text books should be modified to meet these goals and there should be separate books for teachers or educateors. Emphesis should also be given on the process of the development of the development of the scientific fact and also on biography of legendry scientist.

Special insentive measure should be given to the science students. Demonstration on the students by preparing and utilizing models based on the common physical and natural phenomena should be given in well facilated laboratories by encurring moderate expenditure or visiting good laboratories. Application of knowledge in solving problems should be given more emphesis above all more emphasis should be led on the training of the trainers. Resources exercise in practical classes are necessary for generating curiosity and skill in students.

148 KARMAKAR DIVAKAR BHARAT (B-2/16, Shubham Park, Sector-26, Pradhikaran, Nigdi, Pune, Maharashra **Pin- 411044).** LEARNING CLUB: AN INNOVATIVE ATTEMPT TO MAKE EDUCATION BETTER.

Teenagers need age-appropriate individualized inputs to optimize their efforts for learning. Mass education system provides scaffold for learning youngsters, but fails to design and execute individualized efforts.

Learning club is an attempt to provided solution to this.

While 1 spent about 20 years as a teacher in different schools managed by different institutions, I had been always trying innovative ways to educate student more meaningfully. Finally1 decided to make myself off the system and experiment some alternative methods for meaningful education. This is the third year I am conducting the 'Learning Club' on full time basis. Second peoples education congress may be a good platform where I can take this activity to many eminent educators in the country, get their valuable comments and suggestions for betterment and make an appeal to promote replication of this model in their respective areas.

A 'learning club' is a group of students, not necessarily of same school/same syllabus/ same standard. These students come together and decide to learn better. Their parents support the activity. All this is initiated by a person who is resourceful as well as dedicated for betterment of education. This person, though a capable teacher, is the 'manager' of the club.

The students decide what they want to learn. They also decide the friends with whom they will learn. They are free to learn individually if they want to do so. The 'manager' provides them resources like different reference books, website, list of resource persons, etc the role of 'teaching' is deliberately avoided and kept restricted to doubt clarification. The student is counseled to select objective of learning that is compatible to his/ her actual stage, irrespective of the standard in which he/she is learning in school. Thus, there is no pre-declared syllabus of the learning club, but the syllabus for each student is 'tailor-made'.

Students are exposed to different learning situations like science projects, excursions, different applets form internet, competitive examination and conference. They are individually made aware of their role for the family members. Different current issues are discussed with them and formation of 'studied opinions' is promoted.

The teacher-student relationship is not an imposed one, but is mutually accepted. The teacher slowly merges with the family and takes the role in student's life as if his/her mother/father would take. Thus, the teacher pro-actively suggest formation of better habits, not only of learning, but also of eating , doing household work and so on. This is of great help to the parents, particularly in a nuclear family with a single child. The teacher pro-actively thinks of vacation programme for children and sees that the vacation is spent more meaningfully.

This paper gives the details of the activity in these three years, tries to analyze the experience of this activity and put forward an innovative working model that can bt replicated anywhere.

149 KHAN, MD.SALAUDDIN (Sr. Lecturer in Econ, Dr. B.N. Dutta Smriti Mahavidyalaya, Hatgovindpur, **Burdwan).** COMMUNITY RADIOAS A MEANS TO SCIENCE EDUCATION.

Transforming India into a knowledge based, creative and innovative society is not a task that an individual or an organization can undertake alone. It has to be huge collective efforts where different actors play their part their part honestly. The organic links between creativity, communications and community must be strengthened through community Radio for negotiating participatory governance, which in turn, will change the internalized structure of hierarchical subjugation and invisibility among the marginalized communities in India. Success of community Radio requires full participation of all citizens.

150 KRISHNA, PRASAD. S.U And. S.RAMAA (Regional institute of Education, Mansagangohtri, **Mysore570006).** A STUDY OF THE RELATIONSHIP BETWEEN THE MENTAL ABILITY AND SCIENTIFIC APTITUDE OF GIFTED STUDENTS OF MYSORE.

The identification of Gifted students in Mysore district of Karnataka state using the different methodologies in order to conduct the enrichments programme for the students were the first initiatives of the researcher. From 1200 students of the population identified 16 students. Using innovative methods of identifying like teacher nomination, peernomination, Achievement test, standard intelligence tests, etc researcher has identified the gifted students. For the gifted students researcher has conducted scientific aptitude test containing Reasoning test, numerical ability test, scientific information test and science vocabulary test to measure the scientific aptitude.

151 KUMAR, PRADEEP (Government Inter College Bhojpur, **Moradabad U.P. 244001).** A COMPARATIVE STUDY OF THE COVERAGE OF SCIENCE AND TECHNOLOGY IN PRINT MEDIA.

The present age is the age of knowledge. Science and technology today has changed the scenario of the society by communication of scientific information among the people. Infact science and society are interrelated to each other. The scientific temper developed among people shows the success of science popularization, which in turn is the indicator of advancement and progress of a nation. Media plays a pivotal role in science popularization by spreading the scientific and technological knowledge among the common man and changing their mindset. The present study highlights the role of print media (Newspaper) towards the dissemination of scientific news/ information, and educating the masses to develop a scientific outlook.

152 KUMAR RAI AJEET AND BAJPAI ANJALI (Lecturer, Faculty of Education Banaras Hindu University **Varansi221005).** CLASS X STUDENT VIEWS ON NATURE OF SCIENCE IN URBAN CBSE BOARD SCHOOLS: AN EXPLORATION.

Scientific Literacy is considered as the ultimate goal of science education with understanding of the nature of science as one of its significant and essential component. An understanding of nature of science is deemed as vital for preparing scientifically issues in their different social roles. An exploration of the pattern of class X students views on certain selected aspects of nature of science is attempted through this study involving a sample of 247 Class X students of CBSE Board schools and a sixteen item for dimensional five point Likert scale. The results indicate that the students were having views that are a mix of both the empiricist as well as the constructivists' perspective on nature of science. The view pattern of male and female students did not differ on the different aspects of nature of science. The result is finally discussed with suggestions for future research.

153 Mishra, Krishna Kumar and Dubey Akhilesh (होमी भाभा विज्ञान शिक्षा केन्द्र, टाटा मूलभूत अनुसंधान केन्द्र, वी0एन0पी0 मार्ग, मानखुर्द, **मुबंई 400088)** हिन्दी में शैक्षिक ई–सामग्री का विकासः एक अभिनव प्रयास।

विगत बरसों के दौरान सूचना तथा संचार तकनीकी के क्षेत्र में आयी क्रान्ति ने समाज में व्यापक बदलावा ला दिया है। संचार माध्यमों में इलेक्ट्रानिक सामग्रियों का दायरा तथा प्रभाव तेजी से बढ़ रहा है। देश में इंटरनेट सेवाओं का तेजी से विस्तार हो रहा है। जाहिर है शिक्षा का क्षेत्र भी इससे अछूता नहीं है। बेहतर शिक्षण एवं प्रशिक्षण के लिए ई–सामग्री आज कारगर साबित हो रही है। सूचाना सेवाओं के विस्तार के साथ आने वाले दिनों में इसकी उपयोगिता तथा उपादेयता बढ़ेगी। दृष्यश्रव्य माध्यमों तथा ऐनिमेशन तकनीकों द्वारा शैक्षिक सामग्री बेहतर तरीके से छात्रों, अध्यापकों तथा आम जनमानस तक पहुँचायी जा सकती है।

इसी संदर्भ में शैक्षिक ई–सामग्री के विकास के लिए होगी भाभा विज्ञान शिक्षा केन्द्र ने एक अभिनव पहल करते हुए फरवरी 2008 में विज्ञान परिषद् प्रयाग में एक त्रिदिवसीय राष्ट्रीय कार्यशाला का आयोजन किया जिसका विषय था ''हिन्दी में शैक्षिक ई–सामग्री का विकास''। इस कार्यशाला में देश के कुछ चुने हुए विज्ञान लेखकों को प्रतिभागी विशेषज्ञ के रूप में व्याख्यान हेतु आमंत्रित किया गया था। विशेषज्ञों से आग्रह किया गया था कि वे विज्ञान के किसी रूचिकर विषय पर पॉवर प्वाइंट या ओवरहेड प्रोजेक्टर पर दी जाने योग्य एक ऐसी प्रस्तुति तैयार करके आएँ जो अंडरग्रेजुएट स्तर तक के छात्रों तथा अध्यापकां के लिए शैक्षिक रूप से उपयोगी होने के साथ–साथ लोकोपयोगी भी हो। तीन दिवसीय कार्यशाला के तकनीकी सत्रों में दी गयी प्रस्तुतियों की वीडियोरिकॉर्डिंग कराई गयी थी। इनमें से कुल 15 व्याख्यानों को डिजिटाइज तथा संपादित करके इलेक्ट्रॉनिक रूप में वेबसाइट डाल दिया है। इसके लिए http://ehindi.hbcse.tifr.res.in नाम से एक वेबसाइट तैयार की गयी है। होमी भाभा केन्द्र की पाठ्यक्रम तथा दूसरी लोकोपयोगी पुस्तकें पीडीएफ फार्म में इस वेबसाइट पर डाली गयी है। हिन्दी संसार तथा उसकी आवश्यकताएँ बहुत बड़ी और व्यापक है। इसमें शिक्षा के क्षेत्र में काम करने की विराट संभावनाएं मौजूद हैं। होमी भाभा विज्ञान शिक्षा केन्द्र के इस छोटे किन्तु अभिनव प्रयास को इसी परिप्रेक्ष्य में देखा जाना चाहिए।

154 MITTAL, C. POONAM (Biochemistry Department, University of **Allahabad 211002**): NON FORMAL SCIENCE EDUCATION: WHAT SCIENTIST AND MEDIA CAN DO TOGETHER.

When we discuss science education, we generally refer to that component which is acquired by students in their first two to two-and-a-half decades of life, through formal education at the primary, secondary and tertiary levels. All students receive some science education till class 10, after which they are required to make choices from among the main major sciences-mostly the choice is between the physical and the biological sciences. Many students who opt for science beyond this do not choose biology, stating that it is an intensely rote-based subject, with little to challenge their brains! It is not difficult to see the information overload in the syllabus. Paradigm shifts are required in teaching of biology, due to the availability of information at the click of a mouse button. Ability to sift the information needle required, from the available haystack, is what is required to make a good scientist, not the ability to memorize the properties of each strand of hay.

Notwithstanding the low popularity of biology as a career option, the social relevance of biological sciences cannot be denied. It is of interest to every citizen, because it deals with areas of common interest such as healthy lifestyle, wholesome diet, environment, pollution, and disease diagnosis

and prognosis. Hence, print and electronic media is full of news pertaining to the biological sciences, making it an important contributor of informal education, from which the average citizen learns throughout life. The role of media in educating the common man cannot be denied, but it needs to be pointed out that all advise emanating from it is not always factually correct, and there is an element of sensationalization of scientific findings.

Large amount of newsprint is devoted to advise regarding what should be eaten and why, but recommendations are often conflicting. Many foods are declared detrimental to health on one day and beneficial the next. Chocolates, tea, coffee, wine are some popular examples. The result is that the average consumer ends up being confused or even disillusioned by the scientific method. There are several reasons for such conflicting reports, which will be discussed in this paper, with an attempt to emphasize that dogmas with regard to food habits are harmful, but may get reinforced if the average, educated consumer gets a feeling that research is always conflicting and therefore not to be relied upon.

It is important that media partners with the scientific establishment to educate the consumer to be able to make informed choices that are realistic and desirable. The media needs to improve its information content to facilitate decision making, rather than make categorical, often invalidated, statements.

Finally, it is emphasized that media can play a very powerful role in non-formal science education, which continues for about three-quarters of the lifespan of an average citizen. Scientists and media must collaborate to make utmost use of this mode of science education to inculcate a scientific temper in the population.

155 NAGARJUNA, G. (Knowledge Laboratory, HΓCSE, TIFR, **Mumbai India**). COLLABORATIVE CREATION OF TEACHING- LEARNING SEQUENCE AND AN ATLAS OF KNOWLEDGE.

The article is about a new online resource, a collaborative portal for teacher, which publishes a network of prerequisites for teaching/learning any concept or an activity. A simple and effective method of collaboratively constructing teaching-learning sequences is presented. The special emergent properties of the dependency network and their didactic and epistemic implication are pointed. The article ends with an appeal to the global roadmap for an altas being built on similar lines as Wikipedia. The portal is launched and waiting for community participation at http://www.gnowledge.org.

156 PANDEY, BRIJESH K. (Kendriya Vidyalaya **Babina Cantt).** COMMUNICATION OF SCIENCE THROUGH SCITOONS SCIENCECARTOONS.

Hundred students of class VI having average performance in their class room of Kendriya Vidyalaya Babina cantt were analyzed for their interest in basic sciences. The students were divided in to two groups. They were examined in class room for their interest in basic sciences by two methods first by conventional method with the help of chalk, duster and black board and second with the help of science cartoon.

The data based on their performance and interest in the classroom were critically examined and analyzed. It reveals that 90% of the students show better performance, understanding and interest who were getting basic science education through science cartoons i.e. Scitoons in comparison with the groups of students getting knowledge through conventional method and it was difficult to create interest during teaching through chalk and talk method.

Communication of science through cartoons seems to have great impact on student in better understanding of basic sciences

157 PATHAN, ZEBUNNISA NURIBHAI. (Navjivan Girls' High School, Dahod Managed by Dahod Anja Mahajan Sarvajanik Education Society, **Dahod GUJRAT).** MODIFICATION IN SCIENCE CURRICULUM OF SECONDARY SCHOOL LEVE.

Considering the science curriculum of other nations our science curriculum lags behind. In order to make balance with other nations of the world it is to be modified. For this purpose one questionnaire for the students and one suggestion questionnaire for the teacher were developed in order to collect data. For achieving these objectives the stratified random sampling procedure was used. The population was consisted of 60 students and 40 teachers form four secondary schools of Gujarat state in which both male and female students as well as teachers were taken. The descriptive survey method was used. The data were collected through personal contact and were interpreted by the help of the statistical procedure.

The result of the study revealed that the present science curriculum is a very low standard in comparison to other developed and developing nations of the world. The students and teachers expressed their views about the modification of the science curriculum in secondary school level which can cope with the curriculum of other nations of the world. Also the investigator found form the study that the science curriculum should provide various special branches from the beginning of the secondary school level and they can continue their study in that particular branch of science throughout life. So our country can get the highly intellectual scientist in various branches. Along with this the discovery and invention attitude among the students must be developed positively FROM the beginning of their study and for this purpose the students should be exposed to the science field trips to nature and science related places. The branches of science be taught are space science, physics, chemistry, biology, zoology, information technology, medicine, mathematics, geology etc. the present study recommends some suggestions for further research in the field of science education.

158 RAJ BALDEV AND SAI BABA M. (Indira Gandhi Centre for Atomic Research **Kalpakkam 603102 Tamil Nadu, India).** ETHICS, EQUITY AND EDUCATION.

Holistic education with ethics and equity is the robust answer to make India a developed nation which is a challenge and opportunity. Educationists, teachers and parents have a specific and complimentary role to realize the desired results. Shaping coherent synergy between teachers and parents though should happen in a natural way is not so easy to achieve. One needs to ponder the ways and means to achieve such a synergy for the benefit of the child and the society. Swami Vivekanand was precise and profound when he said, ***"We want that education by which character is formed, strength of mind is increased, the intellect is expanded, and by which one can stand on one's own feet".***

The school is a foundation for a society's creativity, prosperity and cultural development. School must therefore be a creative environment in which sports and artistic forms of expressions (music, dance, theatre, literature etc.) are counted as essential skills in addition to theoretical and practical skill-set. There is a distinct and characteristic commonality between the practitioners of Science and Arts (Painters, Writers, Musicians).

The focus of teachers, parents, educationists, administrators and policy makers is to design and implement a system for imparting holistic education. Holistic education at different levels of schools and colleges in a society with unique mind set and cultures need to be defined clearly. This in itself is a major challenge requiring best of the minds to come together to reach the desired and acceptable goal.

Imbibing ethical values while imparting education should be the focus of the teachers and parents. We all experience that almost all human beings are born ethical. Ho·vever, they do not stand ethical as they grow. The foundation of ethical values is invariably laid by parents and teachers in the early stage of a life of a child. Thus, the focus is to select the teachers who want to teach, have the requisite qualities and abilities to teach the child and continuously enhance and inspire them with skill sets and motivation. With the rapid progress being made by India, it is an opportunity for the students, teachers and the parents to combine the best of the east with the west to discover a balance which would enable success for young children when they grow up and provide them with better quality of life balanced with societal commitment.

At Kalpakkam, we have taken initiatives to impart holistic education to the children for over all personality development along with capacity to learn on their own with passion without neglect of the rigorous of curriculum demands. Providing educational avenues (vocational, job oriented and formal) to

the needy and deserving for our neighbourhood has been one of our priority areas. Even though this challenge is our focus; results are far from satisfactory with current level of pursuits and strategies. Our approach to bring ethics and equity in our neighbourhood through education and imparting skills shall also be highlighted in the paper.

159 RUCHA GUJAR AND SONONE B. ASHWIN (Senior Lecturer: School of Continuing Education Yashwnatrao Chavan Maharashtra Open University Near Gangapur Dham **Nashik –422222).** EVALUATION OF THE TELECAST OF VIGYAN PRASAR EDUSAT SCIENCE PROGRAMMES.

The focus of the paper is to evaluate the Role and Effectiveness of Vigyan Prasar Edusat Interactive Communication Network on Popularizing/ Disseminating Science Education. The study falls in the area of communication, Science education and educational technology. For the purpose of data collection experimental and survey research methods is being used.

The information and communication technologies revolution has continuously transformed life in society, bringing new demands, as well as novel expectations concerning education, such as convenient flexibility in time, location and structure. It is true that technology is changing means to acquire information, for example the introduction of new technologies have taken us from using one single medium to transmit information through multimedia, from the considerably narrow band to broad band, from access through the net to wireless access, and from the user who had to adapt to technology, to the technology actually adapting to the user. The impact of technology is still rippling through society. It has tremendously changed the way how we acquire/use digital resources, new modes of communication, rapid dissemination of information, collaboration and dialogue with peers from around the world, and free flow of ideas. While the societal/social impact of technology is still in its infancy, the greatest challenge facing the role of technology may well be in the creation and distribution of knowledge and information. Teaching-learning has long been fondly cherished by us all as a classroom activity – a concerted effort on behalf of a teacher, his students in the class, with the blackboard, chalks, books and copies… . With the advent of the 21st century, a supreme insignia of modern technology has deeply underscored every facet of human life. One such aspect, which is undergoing a sea change, is our ways of teaching and learning. The scenario in education is fast changing due to factors like, (i) development of new educational tools, which integrate different features of Multimedia for educational purposes; (ii) ready accessibility of the educational content through various facilities like Internet, educational broadcasting using satellite technology, etc.

Satellites can establish the connectivity between urban educational institutions with adequate infrastructure imparting quality education and the large number of rural and semi-urban educational institutions that lack the necessary infrastructure. Besides supporting formal education, satellite systems can facilitate dissemination of knowledge to the rural and remote population about important aspects of health, hygiene and personality development and allow professionals to update their knowledge base as well. Thus in spite of limited number of trained and skilled teachers, the aspirations of the growing student population can be met through the concept of tele-education. The major advantages of satellite-based Distance Education include:

- Simultaneous delivery of lecture sessions to a large number of geographically dispersed people in the shortest time
- Uniformity of the lecture content
- Access to the subject expert and his/her lecture material
- Repeatability of delivery of lectures from the archives
- Capability to share the same network by different user groups
- Significant savings in expenditure due to economies in travel, logistics and replication of teaching infrastructure

Alternatively,the EDUSAT programmes would supplement the present teaching system all over the nation. It gives the university community a great deal of opportunity in employing EDUSAT network in the teaching-learning process thereby the "best of breed" could be expected from every educational institution. The wider picture is that, this will give a thrust to distance education. Education will be

available at a fraction of its cost to a large number of students i.e. higher education A large number of students can be educated by a very few extremely efficient teachers who can reach them from the studios located in the universities or education boards. Education can be taken to the students rather than students walking long distances to schools as in the case of rural India. Students can receive education at their own pace and at their own convenience especially those who are employed.

160SARODE, SEEMA AND PANDIT RASHMI AND KOLHEKAR SUHAS (Akksharnandan Primary & secondary school Survey No. 103, Shivaji Hsg. Society. Senapati Bapat Road, **Pune-16).** SCIENCE EDUCATION IN AKSHARNANDAN.

Today's education has been sadly reduced to a competitive, career oriented system, with an undue emphasis on rote learning and mindless examinations. Schools have become large, loveless, often-lawless establishments offering little contact between pupils and teachers, between schools and society resulting in declining interest in education.

As per the curriculum present science education is designed with the perspective that students should acquire the skills of observation, classification and drawing inferences and then understand the co-relation between scientific ideas, concepts and human life and develop a scientific temperament.

Aksharnandan is committed to bring this perspective into practice. Aksharnandan the name itself is meaningful. The word Akshar has two meanings – in Sanskrit Axar – a letter and one which does not diminish. Nandan means paradise. Thus through innovative practices we are trying to create an abode of joyous learning and enduring values i.e. Aksharnandan.

In Aksharnandan education is intrinsically linked to the kind of individuals and society we envisage. Education is a process to awaken intelligence, not merely intellect, to cultivate independence of mind and to inculcate values to help children grow into wholesome, productive, creative and responsible human beings. Science education has a role to play in this endeavor.

Basic objectives of Aksharnandan are applied to science teaching as well.

Child centred education system – While learning the subject students understand the concept through songs, stories, even draw pictures, make songs and poems too. This makes the topic easy to understand and takes us significantly towards child centred system of education.

Interdisciplinary approach – In the school the interdisciplinary approach begins with a theme, personal issue, social problem, school event, science topic and applies the concepts and methods from more than one discipline.

Learning through the environment, about the environment and for the conservation of environment – To enhance the environmental awareness among students many outdoor activities like field trips in and around the school campus, organic farming, vermin-composting as well as overnight residential 'shibirs' are conducted.

Emphasis on co-operative learning rather than competitiveness – Students are arranged in pairs or small groups to help each other learn the assigned topic on their own.

Our motto is to make the students understand the basic concepts of science. Rather than classroom studying and learning text books, we use various methods that give direct practical experience and feel to the student. It helps the students to learn effectively. This makes it easy to inculcate scientific attitude in them and thus develop a healthy attitude towards environment. This awareness spreads from students of Aksharnandan to other children and their families in the society.

161 SHARMA KUNDAN LAL (Vill: Thaneek Pura, P.O. Bharwain, The: Amb, Dist. **Una Himanchal Pradesh).** भारत में विज्ञान शिक्षण.

समूचे जीवन की निर्भरता इस पर इस सीमा तक हो गयी है कि सीखे बीना मानव जीवन की कल्पना करना कठिन है। मानव सभ्यता से भी पहले जब जैव विकास शुरू हुआ तो कुछ ऐसी बड़ी घटनाएं घटीं, चाहे वह पृथ्वी पर थी, अन्तरिक्ष अथवा समुद्र में हुई, वर्तमान अध्ययनों से पता

चला है कि वे सभी कि सभी वैज्ञानिक सिद्धान्तों के अन्तर्गत घटी। उन्हें किसी वैज्ञानिक ने प्रशस्त नहीं किया। न ही इससे प्रकृति के विकास की दर घटी। प्रकृति ने बहुत बड़े–बड़े विस्फोटों, भूकम्पों अथवा विभेदानों के बावजूद भी पर्यावरण के संतुलन को बनाये रखा। इसमें कोई परिवर्तन नहीं होने दिया, जिसकी आज के पर्यपेक्ष में सर्वाधिक आवश्यकता है।

जब विकास के अर्न्तगत मनुष्य में प्रकृति को समझनें की जिज्ञासा उत्पन्न हुई, बस वहीं से विज्ञान का प्रादुर्भाव हुआ और इसमें संसार के विभिन्न देशों के शोधकर्ताओं के योगदान से उत्तरोत्तर विकास होता चला गया और यह क्रम अभी भी जारी है। भले ही इससे पर्यावरण का ह्रास होता चला गया। वैसे तो ईसा से हजारों वर्ष पूर्व से लेकर, परन्तु सोलहवीं सदी से लेकर आज तक विशेष कर बीसवीं सदी के उत्तरार्ध में विज्ञान ने जो करवट ली है, वह सर्वविदित है। परन्तु एक और मानव जीवन को अधिक से अधिक सुविधा जनक बनाने के लिए जो पर्यावरण असंतुलन पैदा हो रहा है, वह एक चिंतनीय विषय है।

आज सारा विश्व विज्ञान के शिक्षण में ऐसा बदलाव चाहता है कि पर्यावरण इसके केंन्द्र में हो। स्वाभाविक तौर पे भारत भी इससे अछूता नहीं रह सकता।

आज विज्ञान का शिक्षण इसके अध्ययन को आसान बनाने के दृष्टिकोण से किया जा रहा है। आये दिन इसकी शाखाओं को उप–विषय बना कर शिक्षा क्षेत्र में उतारा जा रहा है। विज्ञान के मुख्य विषय भौतिकी, रसायन विज्ञान एवं जीव विज्ञान आदि आज विभाजित होकर बीसियों शाखाओं के रूप में पढ़ाये जा रहे है।

मेरी राय में, प्रथम अलग अलग पढ़ाये जा रहे विषय चाहे वह भौतिक विज्ञान, रसायन विज्ञान, जीव अथवा भू विज्ञान हो, वह अंततः अलग अलग विषय के विशेषज्ञ तैयार कर रहे हैं, उन्हें अपने विषय का अच्छा ज्ञान है। वे अपने अपने क्षेत्र के धुरंदर है। अंतराष्ट्रीय अथवा राष्ट्रीय स्तर की किसी भी स्पर्धा में वे कम नहीं आंके जाते। परन्तु क्षेत्रीय स्तर पर यह अध्ययन व्यवहारिक तौर पर सीनीय लोगों की समस्या समाधान के अनुरूप नहीं उतरता।

वहां पर Physics, Chemistry,Biology, Geography, का अलग अलग अध्ययन करने की बजाय, समग्र एवं व्यापक अध्ययन ही हो। उदाहरण के लिए इन शिक्षण भूखंडों के किसी विशेष क्षेत्र को लेकर उस क्षेत्र का अध्ययन एवं शिक्षण वहां की मिट्टी, पौधों, और अगर कोई रसायन है तो उनकी भौतिक स्थिति को लेकर समग्र रूप से करवाया जाये तथा यह शिक्षण अगर B.Sc. स्तर तक नहीं तो कम से कम इंटर तक अवश्य ही करवाया जाये। तदनंतर यह विद्यार्थी आने वाले समय में ऐसे अध्यापक बने एक ही शिक्षक उस विशेष क्षेत्र के लिए क्षेत्र विशेषज्ञ कहलाये न कि विषय विशेषज्ञ। यह व्यापक विज्ञान शिक्षण एवं अध्ययन आने वाले समय की मांग है। इसे नकारा नहीं जा सकता।

इसके साथ–साथ बहुत ऊंचे स्तर का विषय–विशेष का शोध कार्य जारी रखा जाये। जिसकी राष्ट्रीय अथवा अन्तर्राष्ट्रीय स्तर पे समन्वय के लिए आवश्यकता होती है। मेरे इस प्रस्ताव का केंन्द्र मुख्यतः ग्रामीण विकास है। उपरोक्त सुझाये गये क्षेत्र–विशेषज्ञ उस क्षेत्र की सभी समस्याओं एवं आवश्यकताओं की जानकारी प्राप्त कर व्यावहारिक तौर पर अपने विज्ञान के ज्ञान के आधार पर उस क्षेत्र के समग्र विकास की योजनायें बनायेगें तथा उन्हें स्वयं ही लागू करेगें। इस प्रकार सीनीय विकास में क्षेत्र विशेष के सीनीय लोगों के अनुभव को साथ लिया जा सकता है। मेरे विचार में यह क्षेत्रीय–विशेषज्ञ राष्ट्र उत्थान में महत्वपूर्ण भूमिका निभा सकते हैं।

मेरी राय में यदि यह दोनो बिंदु विज्ञान शिक्षण में परिलक्षित हों तो यह विषय परोक्ष रूप में अपने उद्देश्य प्राप्ति की ओर स्वतः अग्रसर हो जायेगा।

162 SHOME, SAURAV PATEL ANKITA and NATRAJAN CHITRA (**Homi Bhabha** Center for Science Education TIFR, V.N. Purav Road, Mankhurd, **Mumbai 400088-India**). SHAKTIPUR NEEDS ELECTRICITY: USING ROLE OF INTRODUCE MIDDLE SCHOOL STUDENT TO DEMOCRATIC PROBLEM SOLVING.

Conventional classroom teaching –learning does not empower student to understand and act in the world outside the classroom and participate in social decision making. Simulating real world context in the classroom is known to have several pedagogic advantages .Involving students in mock decision making by simulating social context in the classroom gives the opportunity for teachers to provide inputs about democratic problem solving. Role play in the classroom has several pedagogic advantages. Students can express their ideas and defend them; critique other's ideas and viewpoints. Students understand that making decisions can be complex when social issues involve economic, ethical and other aspects. Context simulations provide opportunities for students to describe facts and evaluate them. This paper describes the experiences of a role-play session with middle school students as part of an 8-day course on Energy and Environment. The context for the role play was a debate. The people of a small town called Shaktipur had already decided that they needed to locate a Power Plant in their town and were now asked to decide on choosing an appropriate energy source for the power plant. The context was aimed to give us insights on student's understanding of energy source for power plant. The context was aimed to give us insights on student' understanding of energy sources for power plant. The activity was carried out with two sets of students in two independent, but similarly conducted sessions.

The group dynamics among the students in the two sessions was found to be different, as was the outcome of the role play. They differed both in qualitative and quantitative ways. The paper will present the exploration and analysis of students' favoured energy source options, and the factors that influenced their choices. The paper will also comment on the effectiveness of the role play of a debate in contributing to democratic decision making as well as on the researcher's role and intervention. The paper aims to generate guidelines for creating democratically effective role play situations in actual classroom settings.

163 SINGH, HARCHARAN NAGAR, CHAKRAVARTI, NILIMA SHUKLA ANURADHA NILIMA, (Central Road Research Institute (CSIR) Delhi-Mathura Road P.O. CRRI **New Delhi-110020).** भारतीय विद्यालयों में वैज्ञानिक शिक्षा का अर्वाचीन से भवितव्य तक स्तर.

वैज्ञानिक शिक्षा का आशय विज्ञान विषयों से प्रदान की गई शिक्षा से है। विज्ञान विषयों का तात्पर्य उन विषयों से है **जिनके नियम तथा उपनियम भा□वत् सत्य होते हैं**। जिस प्रकार प्रकृति की परिवर्तनशीलता और समय की गतिशीलता पर कोई प्रश्नवाचक चिन्ह नहीं लगाया जा सकता है उसी प्रकार वैज्ञानिक विषयों में प्रदत्त शिक्षा के बदले स्वरूप पर भी कोई प्रश्नवाचक चिन्ह लगाना असंभव नहीं तो दुष्कर कार्य अवश्य ही है। पुरातन में वैज्ञानिक विषयों की सूची में भौतिकशास्त्र, रसायन विज्ञान, गणित तथा जीव विज्ञान आदि विषयों को ही शामिल किया जाता था परंतु अद्यतन में तो वैज्ञानिक विषयों के नियम, उपनियम तथा महत्ता भी इतनी ही महत्वपूर्ण है जितनी की उपरोक्त आधारभूत वैज्ञानिक विषयों की। भारतीय विद्यालयों में वैज्ञानिक विषयों में शिक्षा ग्रहण करने वाले विद्यार्थियों की संख्या में तुलनात्मक ह्रास हुआ है। जिसके कुछ महत्वपूर्ण कारक दृष्टिगोचर हो रहे हैं।

- उद्देश्य विहीन और लक्ष्यहीन शिक्षा
- शिक्षण में उच्चस्तर तक आरक्षण
- भ्रष्टाचार
- ग्रीबी
- बेरोजगारी
- शिक्षकों में उत्तरदायित्व की भावना का अभाव
- पाठ्यक्रमों के चयन में असमंजता (परंपरावादी पाठ्यक्रम)
- भाषागत समस्या
- तुलनात्मक रूप से शिक्षण संस्थाओं की कमी
- राजनैतिक अवसरवादिता
- कमजोर निरीक्षण प्रणाली
- सामाजिक वर्चस्व और लिंग भेद
- व्यवसायीकरण
- निर्देशन का अभाव
- जागरूकता का अभाव
- परंपरावादी शिक्षण प्रणाली
- प्रादेशिक भाषाओं में वैज्ञानिक विषयों के रूपान्तर का अभाव
- तुलनात्मक रूप से प्रयोगात्मक परीक्षणों की कमी
- दूरदर्शिता और पारदर्शिता का अभाव
- शिक्षकों के प्रशिक्षण में समयानुकूलता का अभाव
- नैतिकता का ह्रास तथा राष्ट्रीय नैतिक चरित्र में गिरावट
- आय (प्रतिव्यक्ति) में तुलनात्मक रूप से कमी
- जटितला

उपरोक्त कारणों के कारण भारतीय शिक्षण संस्थाओं में वैज्ञानिक विषयों में संख्यात्मक प्रतिशत में गिरावट आई है। अगर हमें विश्व स्तर पर विकास की अंधी दौड़ में शामिल होना है तो उपरोक्त कारकों पर आत्ममंथन करना होगा क्योंकि विकास रूपी आंखों के लिए ये वैज्ञानिक विषय ही अंजन होते हैं।

164 SINGH, SHRI KANT AND SINGH RAM PRATAP (363, Shastri Nagar, P.O. Kachahari, **Jaunpur-222002.**). SYLLABI OF SCIENCE EDUCATION IN SCHOOLS, COLLEGES AND UNIVERSITY.

The Paper will discuss the course and contents of syllabi of Science Education in Home (as a natural first preschool and child development centre), informal education process, formal schools, colleges and universities. The course content at various stages will be systematically organized and its purpose discussed. The foundation for emerging Science Education, its development for new research capabilities and productivity enhancement in Technology and creativity is aimed.

It will discuss at appropriate stages the Home Science experience, Every day Science. Health and Physical Education and Agricultural Science along with protection and feeding of Agricultural and dairy

animals, beginning at the Primary School level to the secondary level and Higher Education in its chosen stream.

At the secondary school level science subjects (Physics, Chemistry, Biology and Math) will be taught as Main and Agriculture as subsidiary subject with practical experiment. Study of social science subject will be subsidiary.

At the Intermediate college stage the main branch will be chosen with brifercation as physical science subject and Biological science subject with Mathematics. Much of the modern science is being discussed in the intermediate science syllabus which may enable the students to understand the graduation course quickly and methodically. We have three years degree course to enrich the students in classical and modern development of the subject.

Post graduate education has to be most modernized and research methodology course and project has to be well organized so that the standard of Research may be raised& problem solving ability developed

165 SINGH, VIJAY (Homi Bhabha Centre for Science Education - TIFR, V. N. Purav Marg, Mankhurd **Mumbai – 400088, India).** IDENTIFICATION AND NURTURING OF TALENT IN SCIENCE.

Talent may be identified unambiguously and at an early age in music or mathematics. Such is not the case with science. Talent in science has a broad and diffused scope. Formally, identification of talent in science is attempted in the late teens and via a series of examinations in our nation. We review these and argue that the National Science Olympiad programme provides a comprehensive identification of talent. Nurture of talent is also problematic. The Government of India has launched new initiatives in the form of (a) Scholarships (b) Institutes (c) Targeted promotion of Undergraduate Research. There exist of course non-formal, individual and private efforts. We review these selectively and describe in particular the National Initiative in Undergraduate Science.

Next we address the issue of whether educational institutes have been successful in fostering content knowledge as well as developing general scientific abilities. Our surveys indicate that students group with high content knowledge are also adept in scientific reasoning skills. Our findings are at variance with similar surveys in the USA but similar to China's. We also propose that Item Response Analysis and Entropy measures be adopted in analyzing tests in India.

166 SOOD, RIPUDAMAN AND DAS, MOUMITA, KAPOOR, NEERA (School of Sciences, Indira Ghandhi National Open University). NEED OF VIRTUAL LABS IN SCIENCE TEACHING AT IGNOU.

At present in India, students pursuing higher education constitute about 7% of the total population. Out of this, more than one fifth are enrolled in the Open and Distance Learning (ODL) system. This is a huge number and poses immense challenges to the ODL Universities to deliver quality and accessibility to education for all. Further, in today's era, the emphasis is on life long learning, which is to be flexible and tailored to suit everybody needs. The Indira Gandhi National Open University (IGNOU) is dealing with such pertinent issues of quality, access and equity, especially in science education. With 1.8 million students, IGNOU has the maximum number of enrollments today. The University imparts science education through the School of Sciences. The School has developed 92 courses, of which 62 courses are on offer in the BSc programme. The other 30 comprise courses for PhD, MSc, Diploma, Certificate and Appreciation programmes. IGNOU, unlike the conventional universities, offers the science programmes through the distance mode. Traditionally, self learning print material (SLPM) has been the main medium for instruction in IGNOU in science programmes. The SLPM is supplemented with audio and video programmes, counselling sessions, assignments, laboratory work, teleconferencing, and video conferencing. These multiple media have enabled IGNOU to reach a wide range of learners across the country. Studies indicate that the science learners of IGNOU are getting the same knowledge, skills or

information for theory and laboratory courses as compared to the students of conventional universities. However, in the distance mode, there is a separation of the learners from the teachers, as they never come face to face. This poses a challenge for IGNOU to impart quality education and inculcate a systematic and logical thinking among learners, and to develop a scientific attitude in the courses that require laboratory work. With the advent of Information Communication Technology (ICT), a new area of teaching-learning has emerged, which employs a combination of e-learning, online support, digital repositories, open source courseware and virtual labs. Virtual labs could prove to be an important supplement medium to impart valuable instructions to the learners, which they might miss during reading the SLPMs, counselling sessions or during practical sessions. The Virtual labs would enable learners to understand the key concepts without going to a physical laboratory. The learners can repeat the experiments as many times as they want to and at their own pace and time, and develop the required level of understanding of the topic. Today, the ODL system is all set to embrace this form of virtual teaching-learning. However, the ODL system has to prepare itself for a new generation of learners who have been using ICT tools in schools. In this emerging scenario, to assess the need of virtual labs at IGNOU, the present study was carried out on the students of BSc Programme. The results of the study are expected to provide an insight into the designing of virtual labs for the future.

167 SUDURSHAN, M. and MARIASAGAYAM, A. (Lecturer Nehru College of Education And Teacher Training Institute Sedarapet, **Puducherry).** RELATIONSHIP BETWEEN RESILIENCE AND TEACHING COMPETENCE AMONG D.T.Ed TEACHER TRAINEES IN PUDUCHERRY.

A sample of (n = 250) D.T.Ed teacher trainees of the academic year 2007-08 of Puducherry region were taken for the study. All these student teachers for their resilience behavior and their teaching competencies were assessed based on appropriate tools and methods. The correlations between the resilience competency were undertaken.

The result showed that there was positive correlations between the resiliency and teaching competency (r = 0.7048). background variable like the influence of age, sex, academic qualification and locality on resiliency were identified and discussed

168 U. NAJEEMA AND V .R. RAGHUNDHANAN (**HSA**, Physical Science, Kerala Agricultural University High School, KAU P.O. **Thrissur, Kerala – 680656).** FORMULATION, DELIVERY AND MONITORING A NEW MECHANISM FOR INTEGRATING HIGH SCIENCE SYLLABUS WITH MICRO LEVEL PLANNING AND DEVELOPMENT.

A methodology for upgrading children's science projects has been evolved through a series of studies conducted in KAU HS during the period 1992-2007. The major components of this methodology are the identification of effective modules from school science curriculum for the purpose of experiential learning. The second component is the identification of appropriate research institutions industries and such other establishments for providing hands on training to the children based on selected modules. The third component is the establishment of linkage between children and community in order to experience and experiment how science is applied in society. Fourth component is the performance of appropriately designed social surveys for linking the education with micro level planning and developmental activities going on at panchyath level. The fifth and last component is the reflective learning practise and introspection for evaluating the ability of knowledge creation in children.

The methodology which was systematically evolved based on Children's Science Congress activities, eco club activities and pedagogy workshops over a period has been finally subjected to an evaluation process. This was done in a five day residential camp arranged in KAU HS campus making use of the facilities of various R & D centres inside the campus as well as outside. The utility

of this methodology in creating deep interest among children in science learning was exposed in the camp. The ability of this was also proved effective to inculcate creativity inquisitions and innovativeness among children. In addition to this the approach also enabled them to understand social and environmental problems and in few cases to solve some of such problems even. The entire process was evaluated by a team of experts and academicians drawn from various institutions.

169 VASUNDHARA, PADMANABHAN AND SNEHAL, NUNES (KJ Somaiya College of Education and Research, Vidyavihar, **Mumbai400077).** FOSTERING OF THE ABILITY OF FORMULATING AND TESTING HYPOTHESES.

The science process serve as scaffolding during scientific inquiry. At the heart of scientific problem solving are the processes of formulating hypotheses, testing hypotheses, evaluating evidence, and revising hypotheses. Science proceeds by a process Observation, hypothesis formulation, hypothesis testing, and on the basis of the test, accepting the hypotheses if the experiments support our assumptions (hypotheses) and rejecting the hypothesis if the experiments do not support our assumptions.

It is also very essential to understand how scientists answer questions about the world they live in by formulating hypotheses and designing experiments to test them. Formulating a hypothesis and designing an experiment to test it are the first steps in all scientific inquiry. Science contributes to developing the ability of critical thinking, with its emphasis on hypothesizing manipulating the physical world and reasoning from data.

The nation has put the onus on teachers to develop scientific attitude and scientific temper among the students. The responsibility of science teachers, therefore, is to develop in the students the ability of scientific method of problem solving, thereby developing in them the scientific attitude and scientific temper.

This would require the teachers to teach science so as to develop in students higher level cognitive abilities such as analyzing, synthesizing, formulating and testing of hypotheses and so on. Then the nation would be able to produce inventors and discovers and not those who just replicate what originally has already been produced.

With this rationale, a research study was conducted at Med leve[1] by The present paper attempt to share the efforts mode to teach a few scientific phenomena by encouraging the students to formulate and test hypotheses

COMMON SYSTEMOF DEMOCRATIC EDUCATION

170 SINGH, R.P. (Reader in Mining Engineering Banaras Hindu University Institute of Technology Varanasi- 221005). प्राचीन आश्रम–शिक्षा पद्धति के पुनरावलम्बन द्वारा आदिवासी एवं वनवासियों की निरक्षरता दूर करने का एक सफल प्रयोग.

प्राचीन काल में भारत विश्व गुरू के पद पर आसीन था। आखिर उसका कारण क्या था ये हमें खोजना होगा। प्राचीन काल में शिक्षा की आश्रम पद्धति थी। शिष्य गुरूओं के आश्रम में रहा करते थे। भिक्षाटन करके गुरूओं की सेवा करके शिक्षा ग्रहण किया करते थे। अपने विषय में पारगत होकर ही आश्रम से विदा हुआ करते थे और पुनः गुरू के पद पर आसीन होकर उस गुरू और शिष्य की परम्परा को पुष्पित पल्लवित करते हुए समाज की सेवा किया करते थे। वहाँ गरीबी अमीरी का कोई स्थान नहीं था। सुदामा और कृष्ण एक ही गुरू के आश्रम में रहकर शिक्षा पाया करते थे। अपने घर से भिक्षा माँगने पर निषेध था। उस समय जब हम दूसरों से भिक्षा माँगकर पढ़ते थे तो जगतगुरू पर पर प्रतिष्ठित थे। आज हम सारे के सारे उन्नत कहलाने वाले देशों के पिछलग्गु बने हुये हैं और शायद बने ही रहेंगे, यदि हमने पश्चावलोकन करने अपनी त्रुटियाँ न सुधारी।

वर्तमान समय में कृष्ण कान्वेन्ट में पढ़ते हैं और सुदामा किसी गांव के प्राइमरी स्कूल में बड़ी मुश्किल से शिक्षा प्राप्त कर पाता है। मगर ऐसा होता क्यों है और उसका जिम्मेदार कौन है। हम या आप या हमारा समाज। अगर गहराई से देखा जाय तो व्यक्ति परिवार तक ही सीमित हो गया है। उसे समाज की कोई चिन्ता नहीं। प्राचीन काल में गुरूओं के आश्रम से जब शिष्य भिक्षाटन करने निकलता था तो भिक्षा पूरा समाज देता था। ब्रह्मचारियों को तो भिक्षा अतिशीघ्र दी जाती थी ताकि भिक्षा में ज्यादा समय न देकर वो शिक्षा प्राप्त करने में ज्यादा सम दें।

समाज व्यक्ति–समूहों से बना है। भारत वर्ष में विभिन्न जातियों, सम्प्रदायों एवं धर्मों के समूह हैं। ये समूह एक दूसरे के पूरक और/या विरोधी के रूप में कार्य कर रहे है। कई समूह या तो राष्ट्रीय मुख्य धारा में सम्मिलित नहीं हो पा रहे हैं या कि असामाजिकता की तरफ मुड़कर अपने समूह की अंशांश कल्याण करने की असफल चेष्टा का दिखावा कर रहे है। ये भटके हुये समूह या समूह के कतिपय छदम नेतागण अंततः हमारी राष्ट्रीय अखण्डता, सम्प्रभुता एवं अस्मिता के लिए खतरा पैदा कर रहे हैं। इसका कारण लेखक त्रय के विचार से अशिक्षा है यह अशिक्षा कम से कम बिना निरक्षरता दूर किये नहीं मिटेगी। इसी विचारधारा के अन्तर्गत सोनभद्र जिले के मधुपुर गॉव में सामाजिक सहयोग से हम लोगों ने 5 जनवरी, 2002 में एक निःशुल्क शिक्षा देने वाला विद्यालय है। हमारा यह प्रयोग आशा से अधिक सफल रहा।

अपनी प्राचीन भारतीय आश्रम पद्धति का पुनरावलम्बन ही हमें इस समस्या का एकमात्र हल प्रतीत हुआ।

171 SHARMA, ARCHANA (Department of Economics Gauhati University **Gauhati-781014** Mob- 98640-66226). EDUCATION FOR THE PEOPLE BY THE PEOPLE: DEMOCRATISING THE TEACHING LEARNING PROCESS.

Most developing countries are blamed to be highly centralized. Even if some of these countries are declared as democratic countries, the democratic style of governance is rarely followed. Top down approach to governance is more common , although they talk of grassroots level planning and governance

This top down approach is reflected also in educational governance. Centralised bodies formulate educational policies, frame curriculum, prepare text books without taking into cognizance the requirements of the common people. The centralization process has only become stronger over time. In the villages, one could see the world bank funded programmes for universalisation of education on the one hand and poorly funded state controlled primary schools on the other, but more students are lured away by the privately managed English medium schools. This may be attributed partially to the homogenizing effect of globalization. Of late, India has also announced that there will be only one central education board and all the state boards will be defunct, text books will also be centrally prepared, to be translated into different languages. The process will undoubtedly be highly expensive and cumbersome. Such curricula could not be expected to reflect the life and culture of the smaller tribes and communities.

Contrary to this, the Mahila Samakhya programme of the MHRD has been doing yeomen's service in spreading among the rural women through a democratic process. The paper narrates the experiences of the Mahila Samakhya programme. It speaks about the process followed in the programme and tries to find out if science education could also be imparted through the process.

SPECIAL PUBLIC LECTURE

172 HEGDE, B. M. (Manjunath Pais Hills, Bejai Mangalore 575004): SCIENCE Vs SCIENTISM

"The central problem of our age is how to act decisively in the absence of certainty."
Bertrand Russell.

Science and scientific temper simply mean curiosity. They are efforts to get to know the secrets of Nature. Many a time Nature refuses to fully divulge her secrets when one goes very close. Children, before they start schooling, are curious but, when they come out they become, by and large, just repetitive robots because of their brainwashing in schools about the accepted norms in science. Occasionally, there are exceptions, but their numbers are very small. To swim against the current is not easy, either. Research depends on grant money; most grants come either from the government or industry. Both masters would like their interests guarded. Refutative research, which tries to demolish the scientific myths, is not funded and so is nipped in the bud. Publishing the data from those studies is almost impossible in the present atmosphere. Even one's position in a University might be threatened!

Scientism, on the contrary, is like a powerful religion that tries to influence people's understanding of this Universe in the accepted norms. Any attempt to show evidence to the contrary is being hushed up with all the might at their command. Scientism was helped by the early successes of technology based on the present scientific paradigm. Society venerates science for the simple reason that we have the telephone, electricity, easy transportation, satellites, space ships, nuclear war heads and the computers et cetera, thanks to the conventional scientific paradigm. In addition, there is this big money business in scientific technology. Powerful countries are sold to scientism because they have been able to build destructive weapons, thanks to scientism. These weapons give the countries enormous powers to dominate the world. The lure of medals and prizes and the large amount of money involved in some of the prizes like the Nobel have even made people fake research findings or plagiarize them from others without acknowledging the original source.

That is how science got a clean chit from society. Let us examine the present strong pillars of science to see how strong and solid they are. The Big Bang, origin and evolution of the human species, the relativity theory and, quantum mechanics are those four pillars. Reductionism and statistics are the pillars of medical science and biology. Darwin's theory of evolution is found wanting in many areas. *Evolution inside a species is different from evolution of a new species; a bird from a fish, for example.* The latter needs thousands of biochemical reactions that individually will have *no survival advantage* when the ultimate new species arrives by accident. The efforts by Richard Dawkins to sell Darwinism to the public are not very scientific either. One example of the very complicated eye developing from a small depression in the earlier species looks rather too simplistic.

The relativity theory, first developed by a German physicist,
Lorenz along with the French mathematician, Poincare, had a significant contribution also from the famous Irish mathematician, Fitzgerald.[7] Albert Einstein, the deified *guru* of physics, had very little to do with it. Einstein, however, had contributed immensely to Brownian movement, photoelectric effect and movement of ions in solutions. Einstein giving away his Nobel Prize money to his first wife, whom he had divorced by then, gives credence to the view, held by some close confidents, that the original Nobel paper of Einstein did have his wife's name as the first author, which must have disappeared later. Many have doubted if he had plagiarized her work!

Be that as it may, the question raised by Prof. Dingle of the London University about the theory remains unanswered so far. The assumption in the theory that there is same velocity of light independent of the direction of measurement with respect to the motion of the earth has recently been found to be inconsistent. The jewel in the crown of physics, the quantum theory, does not seem to have much connection to reality. We still do not have answers to questions like a) what is a wave function? b) In the Schrödinger's equation what are the waves "of" and what are the waves "in"? and third c) what *is* an electron?

The basic problem in the theory of evolution would be, if we accept that there is no *design* and there is no *teleology* as sold by the scientific establishment, to explain the prior existence of the DNA! The accepted laws of chemistry need chance collisions between simpler constituents.[13] Darwin's book *Descent of Man* makes it mandatory for us to discount any *design.* Dawkin's book *The Blind Watchmaker* makes an effort to whitewash these questions! Lamarck must have had his last laugh in his grave when he came to know that rats developed diabetes following destruction of their pancreas by drugs: they then passed the disease on to their offsprings-evolution through inheritance of acquired characteristics-Lamarckism. One would benefit a lot by understanding the word *Entelechy*-spontaneous development of order, as opposed to *entropy*-disorder, first coined by the German biologist, Driesch (1867-1941).

NASA claims that there is no life anywhere outside the Earth, but they could not discount bacterial life deep down the surface of Mars. There are some indicators to that possibility in the recent works. Mathematics, the foundation of all sciences, including the King of sciences, physics, can not explain many of our experiences in life. Let me quote Albert Einstein himself here: "Insofar as the propositions of mathematics give an account of reality, they are not certain; and insofar as they are certain, they do not describe reality." If there is no *design* how could a high school student, Ramanujam, write down large number of new and original theorems, some of which he could prove but, some others he simply *stated as true*, and were later proved by other mathematicians at the Cambridge University?

The remarkable picture of that gigantic explosion, the Big Bang that began the Universe: the latter expanding ever since, is understood even by a school boy/girl. What happened before the Big Bang? Maddox, the then editor of *Nature,* in 1989 did write that Big Bang theory would be forgotten by 2000 AD. Edwin Hubble did put forward arguments against the theory but the big one bangs on! The *Tired Light* hypothesis shows that the Universe is not expanding. All that we can say about the universe today is that it is very, very old. The million-dollar question as to how the world began remains unanswered! Big bang and the Black holes make good material for lay books that are sold like hot cakes and make their authors very rich, but most of that stuff is still in the realm of science fiction!

Science deals with our five senses only. What the senses can not measure and observe does not make science in the present paradigm. However, the observers' consciousness impinges on the findings. An electron is what it is depending on who looks at it! When no one is looking at the electron, no one knows what the electron does![24, 25] There are a lot of things in this universe that our five senses can not realize and they exist all the same. Science does accept that what is known today could be proven wrong or replaced by a new theory tomorrow, but to say that what we don't know today (or what does not fit into the present paradigm) is unscientific is illogical. But that is exactly what scientism is trying to do.

To give a few day-today examples: we are not able to measure our thoughts, our emotions, and many of our actions based on those emotions and thoughts. Do they, then, fall out side the realm of science? Do thoughts exist? Do emotions have any role in human physiology?[26] If the answer is yes, then we need a change of paradigm in science, at least in medical science, where the RCTs (randomized controlled studies) have been sold as the last word in medical research. The truth is that there is everything wrong with this approach. No two human beings could be compared based on a few of their phenotypical features. The results are there for all to see. Most, if not all, RCTs have given unreliable results in the long run. But look at the following in the encyclopaedia of RCTs published by the establishment!

"A major difficulty in dealing with trial results comes from commercial, political and/or academic pressure. Most trials are expensive to run, and will be the result of significant previous research, which is itself not cheap. There may be a political issue at stake (cf. MMR vaccine) or vested interests (cf. homeopathy). In such cases there is great pressure to interpret results in a way which suits the viewer, and great care must be taken by researchers to maintain emphasis on clinical facts.
Most studies start with a 'null hypothesis' which is being tested (usually along the lines of 'Our new treatment *x* cures as many patients as existing treatment *y*') and an alternative hypothesis ('*x* cures more patients than *y*'). The analysis at the end will give a statistical likelihood, based on the facts, of whether the null hypothesis can be safely rejected (saying that the new treatment does, in fact, result in more cures).

Nevertheless this is only a statistical likelihood, so false negatives and false positives are possible. These are generally set an acceptable level (e.g., 1% chance that it was a false result). However, this risk is cumulative. **There is a tendency for these two to be seized on by those who need that proof for their point of view."**[27]

Before we do more damage to mankind by blindly following the reductionist paradigm, at least in medical sciences, let us think of a new paradigm.

Let research be directed to find out the myths and dogmas in the present paradigm to replace them with newer ideas and findings that might make life easier for mankind. Of course, it might destroy our "rice bowl" for the moment, but we might get a bigger bowl in future. Scientific temper should make us identify the false dogmas and enable us to destroy them. Science is change and what does not change is not science. Professor John O'M Bockris so beautifully describes the new paradigm shift that is needed in science in his classic *The New Paradigm.*[3] What does not change becomes religion. That is why I sometimes feel that scientism is a kind of religion we are made to follow blindly. Present science is excited about *nanobots* but does not bother about our giga problems like environmental pollution, abject poverty of the majority, preventable illnesses which kill the poor and unemployment of the majority!

It is preposterous that medical science does not worry about health promotion, while it goes overboard about disease interventions, many of which make the patient worse! Sir William Osler had warned us not to intervene when the patient is doing *well*, but that is exactly what we do today! Medicine does not believe in the wellness concept. Everyone is ill unless proved otherwise is the present paradigm, thanks to the total body scanners. Routine check up is the biggest medical industry, while we know that predicting the future is impossible in a dynamic human system using a few data of the initial state. Even changing those parameters might not hold good as time evolves.[28] Changing those parameters might even harm patients in the long run, while it is mandatory to do so if the patient is symptomatic and is suffering, because doctors are here to *"cure rarely, comfort mostly but to console always."*

The effort here is not to belittle the *great* strides science has made in the last two centuries. The stress here is to let the reader know that there is so much *noise* in this area that almost drowns the *signal!* Unless we silence those *noises* and try to pick the *signals* science will not progress and mankind will still be in the dark.[29, 30] Even if one person is stimulated to think on those lines, the purpose of writing this will have been achieved, despite the fact that 99% of the readers would be angry or unhappy about the contents. Conventional journals would hesitate to publish this piece for obvious reasons-their peer reviewers will not permit it and the editors dare not take the responsibility themselves!

173 GAUTAM, R. DESIRAJU (Solid State and Structural Chemistry Unit, Indian Institute of Science **Bangalore, 560012):** QUALITY AND QUANITY IN SCIENCE EDUCATION AND RESERECH IN INDIA.

Scientific progress is the hallmark of any dynamic and progressive society. The quest for a scientific temper in today's world has been rendered almost imperative, as it is seen as the key to global economic and political influence. It is believed that scientific enterprise is often the best rebuttal to ignorance, superstition and hypocrisy. Science encourages a logical, quantitative and systematic approach to life, rapidly empowering and enriching those who embrace it. Many developing countries have realized the importance of science both as a means of advancing technological progress at home, and as a way of establishing their prestige and status abroad. India certainly has made many moves to increase and improve scientific activity since independence in 1947. The feeling today, however, is that many aspects of our scientific development have been unsatisfactory. When compared with what China has achieved over a similar period of time, the Indian contribution is singularly lacking in both quality and quantity. Many other developing countries have faced similar problems. The purpose of this lecture is to analyse this phenomenon further and to suggest some avenues for both discussion and action.

Quality and quantity are two characteristic attributes of any educational and technical enterprise. Given limited resources, how do educationists, policy planners, bureaucrats and politicians address this

issue, which affects all of us, high and low, rich and poor, educated and uneducated? Does one attempt to educate the largest number of people at the lowest possible level and provide a sound foundation in the hope that this will eventually lead to progress at the higher levels? Or does one strive immediately for excellence at the highest levels in the hope that this will have a trickle down effect in due course? It is tempting to state that one should try for a combination of both these models. The real challenge is in establishing exactly the balance between the trickle down and trickle up models. It is a scientific dictum for such bivariate phenomena that vary inversely (Progress = Quality × Quantity) that it is possible to quickly increase either variable (in this case either quantity or quality) with adequate inputs of money, time and effort, but that even a marginal increase in *both* quality and quantity *simultaneously* is formidably difficult.

From the point of view of scientists, social scientists and policy makers, India is a very good if challenging arena in which to study these issues. The country is of a huge size and is socially, culturally, economically and educationally very heterogeneous. Simple models are generally not applicable in India. It is likely that if a solution is found for an educational issue in India, a simpler version of this solution will in all likelihood be applicable for smaller, more homogeneous countries in the developing world. Additionally, there are several advantages in being large and heterogeneous. Unfortunately, India has not been able to really leverage these advantages to its benefit in any tangible way. Modern scientific paradigms also hold that complexities, weaknesses and adaptability often yield solutions to difficult problems that elude approaches that rely on simplicity, strength and directness. Such approaches, it is felt, are more suited to the solutions of complex problems, and there can be no better example, scientifically, of a complex system than the entity we call India. My subsequent remarks will pertain only to India but you will note that almost all of them could be extended, in one way or another, to the developing world.

Issues of quality and quantity hardly mattered in former times because not many young people aspired for an education beyond school, and few even completed elementary school. Thirty or forty years ago, the scientific research scenario in India was simple. Life itself was simple. We had a few old colleges from the pre-independence era, colleges that had outstanding programs for undergraduate teaching and did not have any false ideas about what they were trying to do and over claim what they were trying to achieve. At the post-graduate level, the number of institutions that undertook competitive research was small—the then fledgling IITs, the IISc, some CSIR laboratories and a few universities. A small number of serious minded students undertook research. After a PhD, they would often proceed for a post-doctoral stint abroad. Their parents did not ask them what their salary would be when they finished their PhDs. An even smaller handful, who returned to India, constituted a new generation of teachers. Life went on. It is important to remember that the research output of the country under this dispensation was by no means of the highest international levels. A few scientists did aspire for this standard, and were successful in part. These scientists, however, were more the exception. They did what they did not because of the system, but despite it. Indian science was I suppose competent given its flimsy infrastructural support and a near absence of equipment. It was a low input, low output, low throughput and low impact situation. Notably though, no one was very anxious and making money was quite far from everyone's mind. A dedicated teacher and a few motivated students could together achieve a happy academic environment. Quality was the goal, and though elusive there was never any doubt about identifying it when it came calling.

Times have changed today, and quite rightly so. At the present, change is knocking on the doors of academia and vast numbers of students aspire for educational opportunities at the highest levels. In the name of democratization, we have been told by our political masters to increase the outreach of our teaching and research programs. Can the system cope with this increase? Over the last fifteen years, there has been a modest increase in the numbers of researchers who are able to publish their work in competitive international journals. This increase is, however, far outstripped by the numbers of research students, their general lack of quality, and their hunger for quick monetary gains. There seems to be a misconception among students about a scientific career. Some of them feel that provided they study hard enough, they can make it at the highest levels of scientific research. Others gravitate to science careers because they have nothing else to do. Both these are extreme positions and both views are ill-advised. However difficult it is for us to stomach, in the fuzzy and loosely socialistic political structure that we now seem to inhabit, I must state bluntly that science research is elitist and discriminatory, and at the highest levels of outstanding quality. Not all can do high level research or become high profile technologists. Native intelligence is a

God given gift. An ability to focus, prioritize and apply may be learned. A combination of these factors with some mysterious intuitive flair goes into the making of a true researcher. Excellence in research is like high altitude climbing or marathon running. It is not meant for all. At more modest levels, a few more can participate, but that's the bottom line. Still, there is nothing wrong in moving from the slow paced quality based system which we had 30 or 40 years ago, to a more accelerated quantity based system, provided the ultimate goal is the identification and encouragement of true quality. One can have both quality and quantity, but it is subject to an important caveat—it is quality for a few with quantity for the many, with all contributing coherently to the progress of the nation. What I wish to affirm here is that without a broad-based sound education for vast numbers of people, there can be no hope ever of accurately identifying, nurturing and recognizing the high fliers. And, in the end, *it is only the high fliers that can take a country forward*. This again is very difficult for our political establishment to countenance but they will have to contend with these basic truths and accept some even more important human behavioral traits even as they continue to obstinately defend many of their anachronistic policies and actions that seem to deny the existence of true quality. In summary then, quantity comes before quality but one can have a bit of both, if one knows what one is doing.

Quantity does not mean loss of quality, and vice versa. Quantity, however, is no substitute for quality. We need to nurture a system of scientific activity in India where one can provide a decent education at lower levels to many students along with a high class program of research at the higher levels for a selected few. How does quality research fit into a quantity based system where everyone wants to study? Education must evolve in two stages: in the first stage a very large number of students must be given a sound undergraduate training in science, including laboratory work. In the second stage, a smaller number of truly gifted individuals must be identified and given a world class education. Simultaneously, those who terminate their education at the undergraduate level (and many should be encouraged to do so) should be provided with decent employment opportunities. A dignified exit option at all levels is a must.

If identification and encouragement of quality is the true aim of a quantity based system, two indispensable elements are required for its successful prosecution: (1) The numbers of students processed at the lower levels must be really large; (2) The thoroughness with which the system is able to identify and elevate quality must be highly efficient. Both points require elaboration.

First, why should the numbers of students at the lower levels be very large? A key assumption in the working of a quantity based system is that the proportion of really talented individuals is always small and constant. So, in a heavily populated country the total number of extremely talented individuals is substantial. I estimate that there are around 200 youngsters in the age group 16-17 with an I.Q. of greater than 140 in each district of this vast country. The problem, however, is one of identification of these individuals. It is like searching for the proverbial needle in the haystack. In the context of a viable post-graduate program, this is why one needs to educate a very large number of undergraduates. Continuing along this line of thought, one needs a bigger pool of school leaving students from which to pick one's undergraduates. In the end one arrives at the elementary school. One simply cannot afford to lose the few children who are truly exceptional even as they remain hidden (even uneducated) amongst the vast numbers of more average ability.

Second, why should the screening mechanisms at each level be very efficient? This is because we would be handling huge numbers. Unless our screening mechanisms are very efficient, the whole system would collapse under the weight of mediocrity. Efficient screening mechanisms are ruthless, discriminatory and dispassionate. The degree of ruthlessness and of discrimination increases as one moves up the educational ladder. The search for quality is about survival of the fittest. One must accept this and be comfortable with such an evolutionary model. Indeed upper level screening in scientific research has very little to do with social engineering and pseudo-leftist or pseudo-liberal thinking. If these latter attributes are deemed to be imperative, then one should abandon higher level science altogether. Accepting my arguments, and with large numbers of students screened effectively and appropriately at all levels, one would get the golden mean of quantity at the lower levels and quality at the higher levels.

Sadly, the present situation is characterized by neither quantity nor quality. In the science context,

no one is really interested in a B.Sc. degree because science as a career is not perceived as a serious option by students and their parents. Only the debris remains in the B.Sc. program. Sub-standard undergraduates become sub-standard PhD students. No scientific institution in India, however glamorously it may be touted by the news media, has avoided this problem of deteriorating student quality. There were days when a small number of bright students somehow drifted into the so-called prestigious places, and there was this fig leaf of respectability. Today, the rot has spread all the way to the top. Students do not want to enter a scientific career because they do not see attractive economic prospects at the end of their studies. I daresay the same situation prevails in the humanities and the social sciences. One may argue with this mercenary attitude on the part of the students, but it is unavoidable in our money-driven society today.

Two themes now need to be elaborated: education as a commodity, and the various stages of this education itself. If one treats education as a commodity, one can identify three main components: input, outputs and the technology that transforms inputs into outputs. Similarly, one can identify four stages of education: school, undergraduate study, postgraduate study and research. Let us take each of these themes in turn.

The inputs in the education venture are the students. We need the best ones, in the largest possible numbers and in all the four stages of education. In the quest for the best students, it is significant to note that there should be no entry barriers at any stage provided the student is able to maintain the quality that is required to move from one stage to the next. In other words there should be a level playing field as far as equality of opportunity to all is concerned. I am not suggesting that all students are equally intelligent. As I said before, native intelligence is a God given gift. I am only suggesting that there should be an equal opportunity for all to study, and provided the student is able to do well at the level at which he/she is studying there should be an equality of opportunity to proceed to the next stage. Please notice that what I am advocating is not more reservations, but good exit options.

The technology that transforms students into finished products for society consists of the teachers, the educational institutions, the laboratories and the infrastructure that underlies the system. By educational institutions I mean the entire set-up of structures that constitutes the bureaucracy and legislation of education. This would also include all the proactive measures that the government and other education providers carry out to ensure that the system performs to a maximum efficiency and output. These institutions by their actions and/or inaction enable or constrain the technology. These technologies also incorporate our mechanisms of rewards and punishments, criteria of accountability, and honesty and transparency of the entire system.

By output, I mean the finished products of education, in other words the students who at the end of each of the four stages should be able to make a considered choice as to whether or not to proceed to the next stage or to take up employment. The most crucial determinant of a quality-cum-quantity based system of education is the presence of a decent exit option at each of the four stages of education. Without exit options, any scheme of education in the modern world is a non-starter. Many of the distortions in the present state of affairs (lack of dignity of a student who quits after high school, the craze for engineering degrees, the flight of students from humanities, sciences and social sciences courses, the exodus to foreign countries either for higher studies, employment or post-doctoral research) stem from the lack of exit options. Government can hardly believe that it has done its job by suddenly creating a large number of seats in brand new, but in fact practically non-existent, institutions and linking these real seats in virtual institutions with caste based reservations at the higher levels, and with not a care for what it has not done at the lower levels. This is state-legitimized lunacy.

Any serious analysis of the education sector in India leads one to the conclusion that the inputs, the first of the three elements in this venture, are seriously flawed at the higher levels. The set of students who are entering our institutions of higher learning today do not constitute a representative sampling of this vast heterogeneous country. This in turn, leads one to scrutinize the preceding stage of education. Inexorably, one descends into an analysis of the elementary school system. It is here that the facts are the most shocking. Drop-out rates in government secondary schools in certain densely populated parts of rural India run to as much as 75%. As I mentioned earlier the so-called "needle in the haystack problem" can

only be addressed if vast numbers of children are able to access proper elementary education. In my view three issues are of mandatory importance, especially in the rural and impoverished areas, and unless the government is able to proactively address them, we have little chance for long term success. These challenges are: (1) Inability of parents to pay school fees; (2) Absence of a school close to the home; (3) Loss of wages that are entailed by a child studying in school. These problems are especially acute for persons belonging to the reserved category. I have mentioned earlier that the success of any quality-cum-quantity based system hinges crucially on large entry pools of students. Unless we are able to become more inclusive and bring these vast numbers of students into the education pool, and then be able to screen them efficiently, we might as well give up the entire exercise and allow the so-called "market forces" to prevail, whatever be the consequences.

An analogy with our failure to bring home Olympic medals is especially appropriate. After 80 years of puffing ourselves up, India was unable to qualify to play hockey in the Beijing Olympics. But the rot had set in 20 years ago, and we were in a state of denial. We constantly keep asking ourselves as to why a country of more than one billion people is unable to bring home even a few medals whereas small countries with populations less than the city of Bangalore often garner up to five medals each. It is tempting to say that our abject failure in the Olympics is because of corruption among the officials. Yes, of course corruption is rampant in India. But is corruption the only reason for the paucity of medals? If one considers the Olympics enterprise in terms of inputs, technologies and outputs, one finds grave shortcomings at each stage.

Let us consider the inputs. If the Olympics gold medals were obtained in relation to the population of the country concerned, the U.S., India and Jamaica would be awarded 13, 51 and 0 medals. In Athens, the numbers of gold medals were 35, 0 and 2. The situation in Beijing was very similar with 36, 1 and 6 medals being awarded to the three countries. What is it that is present in Jamaica but is lacking in India? How does a small country like Portugal (population 10.7 million) get 2 or 3 medals every Olympics? A survey has been carried out which indicates that the total medals tally of Portugal correlates with the availability of radio and television in that country. In other words, perhaps many people in India do not even know what the Olympics are, to want to think of a career in sports. At the technology stage, we lack proper facilities and money to train athletes. At the output stage, the athletes who have somehow miraculously cleared the hurdles of the two first stages have to contend with corrupt officials. So, the country has lost at every stage, and it may be confidently, and quite scientifically, predicted that it is impossible for us to ever bring home an Olympics medal, except for pure flukes like Rajyavardhan Singh Rathore, Karnam Malleswari and more recently in Beijing Abhinav Bindra, who have garnered their medals despite the system and not because of the system. After Mr. Bindra won his gold medal, Mr. Arnab Goswami was positively bullying his father on the T.V. wanting to know if a poor man's son could ever win an Olympics medal for India in shooting. Is it Mr. Bindra's fault? The fact that cricket has taken off so well in this country adduces proof for my assertion. Cricket, especially of the ODI variety and 20-20, really took off in India only after the game became popular in smaller towns. By taking off, I mean that we actually started winning games, rather than just participating. Both Kapil Dev and Mahendra Singh Dhoni are small town boys. Gone are the days when the city of Bombay and the activities in and around Shivaji Park could dominate the game at a national level. Imagine what would happen if cricket became a known commodity in remote villages! No one would ever be able to beat us again. The same thing can happen in education.

In the higher research context, can one think of a breakthrough solution for our problems? High levels of student participation at the undergraduate level demand budgets that are much higher than what we are able to conceive of in India. China has opted for this route and has set up 100 universities each with a budget of around 100 crore per year, and each handling 10,000 students. They have especially emphasized laboratory training, which is essential for all science education. This would amount to an outlay of Rs 10,000 crore per year but at least 250,000 students would receive a good undergraduate degree every year, and this is no small number. I do not believe that a sum of Rs 10,000 crore per year for undergraduate education is large given today's realities (the DAE gets roughly Rs 7,000 crore every year) but there is a total lack of political will to take such a decision. Air India, for example, wants Rs.10,000 crore to bail it out of the red. The crippling administrative and bureaucratic set-up we have only compounds the problem. I am absolutely

sure that sub-critical efforts like starting five IISERs, each admitting 65 students a year, eight new IITs, 15 central universities and 14 "world class" universities will take us nowhere. These efforts are truly sub-critical and they have been initiated, in several cases, with very little forethought, planning or attention to detail. Within a few months of starting the new IITs, serious lacunae and inconsistencies have surfaced with respect to their functioning, student intake and teacher shortage to the extent that it is already feared that these new IITs will have a deleterious effect on the entire IIT system.

In conclusion, let me say that in all successful countries, quality and quantity are two sides of the same coin of excellence. Because of this almost willful neglect of both quality and quantity India is paying a bitter price today in the field of education and research. Sometimes, even complex problems have simple solutions. Politicians, who have contributed the most to the present sorry state of affairs, need to view students as potential assets for development rather than as vote banks to be exploited through the device of caste reservations. Bureaucrats need to worry less about securing their own positions through their own peculiar and self-appreciative variety of obfuscation, procrastination and consensus-linked half measures, while scientists and teachers need to worry more about the exclusiveness and dignity of their profession rather than about the latest mood changes among the bureaucratic and political class. In the end, it is the student who suffers because he or she has to make do with ad hoc solutions. Already, there is disturbing evidence of what happens when one fails to read the writing on the wall. The sharp increase in coaching classes, non-accredited universities and colleges, in fact all kinds of dubious arrangements that hawk and peddle education are very common now and indeed quite popular. The country is losing an enormous amount of foreign exchange in fees paid by Indian students studying abroad. It is better if we think about the entry of foreign universities into India today and properly regulate such activity rather than wait for a time when their entry becomes unavoidable and under terms and conditions that are disadvantageous to the country.

We are practically in the death throes of our 60 year long ill-fated experiment with education and research. There are many who say that it is already too late to do anything meaningful. There are others who say that the system is so much beyond repair and that it must be destroyed before it can be rebuilt. I will only add that what we need are idealists rather than optimists or pessimists. An optimist refuses to view reality. A pessimist thinks he sees it only too well. An idealist recognizes that reality is always changing.

I thank Prof. T. Krishna Kumar, Retired Professor of Economics, Indian Statistical Institute, Bangalore, for many helpful comments and suggestions. Financial assistance from the

Exhibition

174 AGASTYA INTERNATIONAL FOUNDATION (**No.2 Gouri Kunj, 28 Palace Cross Road, Bangalore - 560020, INDIA**). SCIENCE ON WHEELS.

100 Agastya 'hands-on' science [table top] models. Agastya models were created to spark curiosity and learning among millions of children, teachers and community members. These models serve as invaluable tools in the hands of Agastya instructors while they use those to facilitate 'hands-on' learning in science. They support several key Agastya interventions, including mobile labs, science centers, science fairs, teacher education, community visits; 'scientists meet children,' and the 'young instructor leader program.' Majority of the models are linked to NCERT / school -6th to 10th grade-syllabus and can be replicated at school or at home. Some models though not directly syllabus related, help to communicate and reinforce important concepts and understanding. All of them aim to promote creative thinking and inquiry. These were designed and created by educators and scientists from several organizations. Please note that few of the models need power to operate

175 CHUNAWALA, SUGRA (Homi Bhabha Centre for Science Education (TIFR), Mumbai). GENDER SCIENCE: AN ILLUSTRATED EXHIBITION.

"Gender and Science" is a permanent exhibition at the Homi Bhabha Centre for Science Education that focuses on the historical disjunction between women, science and technology, and the notable women scientists who challenged it. The exhibition attempts to highlight the often hidden role that women have played in science and technology. It presents the examples of several women scientists indicative of the role of women in science.

Historically both men and women have tried to understand their environment and solve problems of daily life using science and technology (S&T) and women have contributed to the technical advancement of humanity, beginning with tool-making & farming. The earliest myths /religions have often placed women at the beginning of agriculture, law, medicine & timekeeping and many cultures till today retain the image of the 'wise woman', the healer, who has access to natural & supernatural knowledge. The deities of knowledge in various cultures have been predominantly goddesses; Minerva (Roman), Athena (Greek), Saraswati (Indian).

However male dominance over intellectual, scientific and technological arenas seems to be a pervasive feature of most human societies. There are various factors responsible for limiting the role of women in science such as: educational discrimination, exclusion from and marginalization in areas considered S&T and de-recognition of those areas in which women excelled, such as, nutrition and midwifery. In India, too, women were excluded from the formal education system, of which the *gurukul* system is an example. Paradoxically, this exclusion coexisted with the occasional symbolic recognition of the importance of women.

Despite scarce opportunities and numerous barriers women have throughout the ages made contributions to knowledge generation. Proper documentation and recording of their efforts is rare. In such a scenario women who made their mark are real pioneers. The exhibition covers aspects such as; the historical background of the problem, women scientists in history, women scientist- the next generation (from 18th century to the present), women scientists from around the world, changing perspectives and images of women in science, perceptions of science, technology and women, and prospects for women scientists, in the new millennium.

Every-day chemistry: some interesting demonstrations

Indrani Sen, Swapna Narvekar and Savita Ladage

Homi Bhabha Centre for Science Education, Mumbai

Chemistry is connected to our lives in a number of ways, some visible and some not so visible. We use many substances daily and if we try to understand these substances, their properties and uses, we are dealing with chemistry. In schools, we are entangled with atoms, molecules, symbols, formula, chemical equations etc and thus we often perceive chemistry as boring and abstract. One effective way to bring out interconnections of chemistry with our lives, is to use and develop demonstrations, that are safe and can be performed using substances from daily life. Activities that will be demonstrated are from acid-base and redox chemistry. Most of these demonstrations are colorful, and will interest observers and directly exhibit interconnections of chemistry with our life.

Equilibria of Inorganic Complexes

Swapna Narvekar, Indrani Sen and Savita Ladage

Homi Bhabha Centre for Science Education, Mumbai

Transition elements occupy the middle portion of the periodic table and are known for their high reactivity's. Often these elements form highly colored soluble co-ordination complexes that has fascinating chemistry. Equilibria of Inorganic Complexes demonstrations present opportunities to discuss and understand key concepts related to co-ordination complexes and binding strengths of different ligands. Co-ordination chemistry is an integral part of undergraduate chemistry. The demonstrations are technically simple, aesthetically pleasing and thus can be replicated in any undergraduate college laboratory.

176 CHATTOPADHYAY, KHAGENDRANATH (Institute of Science Education, Burdwan University P.O.- Golapbag, Dist.- **Burdwan, W. Bengal, PIN- 713104**).
DETERMINATION OF DENSITY OF LIQUIDS.

Density is defined as mass per unit volume. So to calculate the value of density of an object, its mass and volume are measured. But I have found out a simple method (which will be demonstrated in the exhibition) for the determination of density of liquids where it is seen that density of liquid can be measured without measuring its mass and volume. The method is very simple and accurate. The materials required are: a one-metre rule, three pieces of string of negligible mass, a solid substance of any shape and of unknown mass, a test tube of unknown mass, and a liquid of known density (e.g. water).

This method is based on the principle of moment of forces only and with the help of three arm lengths of the metre scale one can measure density of liquid. This method is useful in schools and colleges (especially in rural schools where there is no physical balance).

The above method has the following advantages:

- there is no need to know the values of mass and volume of the liquid.
- the only measurable quantities are the three moment arms.
- a physical balance is not necessary.

I have published this method in the journal *'Physics Education'* (UK) [ref. Vol. 43, page 203-205, 2008] and want to demonstrate the above method in the exhibition of second people education congress.

177 DAS, SUJAKANTA And MITRA, SUBHADYUTI: DEVELOPMENT RESEARCT COMMUNICATION ANÓ SERVICES (*Centre, 58 A Dharmatala Road, Bosepukur, KASBA, Kolkata -42,).* SCHOOL GARDEN – A LIVING LABORATORY.

A garden is a planned space with plants and other forms of nature, usually outdoors, set aside for the display, cultivation and enjoyment. A school garden offers a wonderful, creative space in which children of

all abilities can experience/learn nature, learn natural science even learn other subjects too. Within the school environment it is like a living laboratory. A school garden helps shaping child's intellectual, emotional and social capabilities and skills.

- Environment protection and care is the major concern in today's world. A garden, which is created and maintained by the children, creates environment protection & caring attitude and sense of responsibility among the.
- Environmental Science (EVS) has been incorporated into the educational curriculum to make our future generation conscious about their social and environmental responsibilities. School gardening can be a part of EVS. It helps not only to learn about plants and environment (some examples: the interdependence of the elements in nature and food web, classification of leaves, stems, flowers etc.,types of seed, germination and pollination, types of soil, insects, friends and foes of tree, the impact of chemical pesticide and its alternatives etc.) but if planned properly, other subjects can also be taught at various levels.
- In a school when a garden is planned, it is not necessary that there should be a big open space or a lawn for the garden. In most of the urban schools, there is not much space for a garden, so there can be garden on the roofs, small tubs, tires or hanging pots.
- A garden can also be considered to learn how to recycle waste (like paper, tiffin waste and waste from the garden itself) through composting and vermicomposting.
- In rural setup, in ICDS centres/primary schools/high schools, there are plenty of option to raise garden to supply vegetable in the midday meal, which can make a sea change in the nutrition status of the children.
- Garden can be very useful for physical activity, the scope of which is decreasing in school but importance is increasing as the food habit and life style bringing troubles like obesity, sugar and cholesterol in blood.

-DRCSC, as an organization promoting alternative education using nature as a tool for long. We have tried out and documented school gardening as a pedagogic approach for last two years. The learning outcome of that will be shared through this presentation on the above mentioned issue.

178 DASGUPTA DIPTA (VEC COLLEGE, MUMBAI). MATHEMATICS THROUGH MIND MAP.

- The ground work of higher education in Mathematics starts with the understanding, that Math is not all about integers and real numbers but it is more about concepts, analysis and proofs to reach a conclusion.
  For many students who have done quite well in their school years in Math, this becomes a deterrent. The fact that understanding a definition is as important as solving a complicated integration problem, for a long time evades the student. ,
  When they do realize the importance of understanding the definition, retaining it and using it in further process of analysis becomes a difficulty in the course of their learning. Such students then try to memorize the proofs without understanding the scheme of the proof. As a consequence they not only loose interest in the subject, but also are unable to utilize learning of the subject in any career that they choose in the future. As Math teachers we know the advantage of learning abstract math is in building one's capacity to analyze, given some premises. If a student has graduated with a degree in a Mathematical Science and has not developed the skill of analysis then somewhere the system of education has failed him.

- Learning of Abstract Math involves three steps
  1. Understanding and retaining new concepts/definition, and axioms.
  2. Understanding the Statement of the proposition to be proved
  3. Understanding Scheme of the proof of the proposition.
  4. Finally retaining the definition and results proved for further study of the subject.

- In my years of teaching this subject, which I love, I have found that fifty percent learners, get

stuck at the first step, i.e ,understanding and thereby retaining a new concept and very few could culminate the fourth point that is use the results proved for further study. As a consequence while I find the students responding quite well in day to day class interactions, when it comes to solving even a simple problem based on a few results proved under a topic, they stagger and often fail. This has been a point of trial for me throughout my teaching career.

- A student very rarely forgets the concept of "profit and loss", not only since he/she has done at least 25 sums on this concept in the school, but also because it is a concept which is used in every financial transaction (real life concept).

  On the contrary when we try to teach the concept of 'cover of a set of real numbers', in most cases the definition is forgotten in seven days, as it is an abstract concept. In such circumstances the question of solving problems on this issue does not arise. Solving problems, based on several interlinked results and concepts, appears more and more difficult. This leads to a situation where the students give up solving problems. And this 'giving up' creates an obstacle in the learning process as we all know that Math /Mathematical sciences could be better grasped by solving problems.
- In my effort to improvise on pedagogical strategies, that can be used to help a student to retain & to ruminate on new concepts, I have tried to apply the technique of "**modern mind mapping**" to my teaching. This innovative psychological technique of note making/note taking has been structured by Tony Buzan and it explores an alternative method of learning.
  Students may be better able to understand, retain and use the concepts and results of a topic of Abstract Math by using mind maps.
- Mind map process in this connection can be used for note making/note taking, of a concept and its bifurcation and growth. I have instinctively always used mental pictures and colours to understand concepts. For example when a student is trying to understand the concept of convergence of a real sequence, a mental picture of a crowd converging towards a point is very helpful. To understand a 'metric space' a picture of real line, distance between any two points on the real line is again very helpful.
- T. Buzn, in his books, gives a structured process to develop a mind map for any kind of note making/note taking for any topic under the sun.
- He recommends several steps to construct a mind map which could be summarized as follows:

- Start with the central idea of the topic, a pictorial representation/image which depicts the concept to the user ("an image often is worth a thousand words and encourages creative thought while significantly increasing memory" [1]). This should be the **central image** of the Mind Map in the centre of the paper.

  Use images throughout mind map, using coloured pens.
- Branch out in every direction, from this central image to various connected ideas and results by using **arrows** of different shapes and thickness indicating the level of importance to the user.
- Use coloured arrows to show the link, using colours significantly("use of colour makes the concepts more colourful and therefore more memorable" [2])
- Where the correspondence is very important use thick lines or specific colours
- Use appropriate spacing.
- Use single printed words to represent the key ideas, words appearing on lines .Make the line length same as word length.
- Use Numbers if required as it will add order.
- Develop a personal style.

- The idea of creating a mind map for each chapter completed, has worked well with a few of my students. As they create the mind map to depict a concept and associated theories, the students are trying to understand the central theme and to develop its ramifications. This in turn not only stimulates interest in the work but also makes the learner more alert towards the thought process, which helps them in retaining these concepts for further study.

- I would like to present as exhibits, some of the mind maps developed by my students of S.Y.B.Sc., under my guidance, for the topics like sequences (delta, epsilon concept of convergence"), Hein

Borel theorem, compact sets.etc.
I am convinced that this revolutionary method, developed by the well known psychologist T.Buzan, when used with the right approach, will go a long way to make students increasingly receptive and alert at any level of learning, especially while learning and understanding abstract Math.

179 KHARTMAL, MEENA (Homi Bhabha Centre for Science Education TIFR), Mumbai). SCIENCE- A HUMAN SAGA: AN ILLUSTARATED EXHIBITION ON THE HISTORY OF SCIENCE.

Homi Bhabha Centre for Science Education has produced an illustrated exhibition on the history of science depicting Science as a Human Saga. This exhibition captures the origins of science, its history, its development upto the modern period. The major themes of the exhibition are—Great Leaps in Early Period; Science in Ancient Greece, Ancient China, Ancient India, West Asia; The Scientific Revolution; Science in the 18th, 19th centuries, Social Sciences, Modern Science. The exhibition is a permanent display at the ground floor foyer of HBCSE and is open for visitors.

Some of the major objectives of the exhibition are:
To depict that science as a development process
To depict the conceptual changes that have taken place in the history, a process which is considered to be seen as a parallel with the conceptual changes that students undergo
To depict that science has multicultural origins
To demystify science

The exhibition is and open to visitors and is a permanent display at the ground floor foyer at HBCSE.

180 GHANEKAR, VIKRANT ;RONAD, ANUPAMA; VARTAK, REKHA (Homi Bhabha Centre for Science Education, Mumbai). STUDY OF DIFFUSION AND THE PARAMETERS AFFECTING THE PROCESS.

Diffusion is one of the fundamental processes by which molecules move. It is a consequence of the constant thermal motion of atoms, molecules and particles. Diffusion basically results in molecules moving from an area of higher concentration to that of lower concentration. The rate of the process is affected by various factors such as size of the molecules, concentration and temperature. The simple experiment explained here helps in understanding this important concept of diffusion and the factors affecting it. This experiment can be easily performed in the laboratory since the three chemicals used are readily available ones. Also, since the chemicals have distinct colours, the results can be viewed with ease.

181 RONAD, ANUPAMA; GHANEKAR, VIKRANT AND VARTAK, REKHA (Homi Bhabha Centre for Science Education, **Mumbai**). DIFFERENTIAL STAINING: CORRELATING CHARGES ON DYES AND CELLULAR COMPONINTS.

Staining of microscopic cells and organisms is a regularly used technique in biology. Differentially staining various organelles within a cell with specific stains helps enhance the contrast and thus aids in easy observation of these structures. In the

experiment described here, human epithelial cheek cells are stained with two stains namely malachite green and eosin. It is observed that these stains specifically stain the nucleus and the cytoplasm of the cell respectively. This specificity can be attributed to the property of attraction between opposite charges. Thus this experiment is a simple educational aid to show the interaction between the anionic and cationic dyes and the charges on the various structures within the cell.

182 SAWANT, PRANITA PATEL, ANKITA CHUNAWALA SUGRA (Homi Bhabha Centre for Science Education (TIFR) V. N. Purav Road, Mankhurd, Mumbai 400 088. India). GENDER AND TECHNOLOGY A DISPLAY ON WOMEN INVENTORS

"Gender and technology" is a display on the contributions of women inventors. The contribution of women to technology is "hidden from history" and the prototype inventor is male. The perception that what women do is not in any sense technological persists despite their involvement in survival technology since the dawn of history. Even today we see a disproportionately low involvement of females at all levels of technology and the contribution of women to the field of technology is by and large invisible. Women appear to play the role of users and consumers alone and not that of designers and developers of technology.

Any technology is the product of social relations and forces and choices are shaped by social arrangements. Areas in which women have contributed such as, child rearing, housekeeping, nutrition and agriculture, have been deemed to be either non-technological or low in technology. Thus technology like science and language is gendered, and its know-how, design, fabrication and maintenance tend to be a male preserve. Historically, women have been excluded from the technological community.

Yet women have played a role in creating and developing innovations that have made human lives more comfortable and productive. Many of us are unaware of the fact that women inventors have contributed in the fields of knowledge spanning from medicine, computer technology, physiology, and physics and hold patents for the same. These inventions include windshield wipers, intravenous catheter, dish-washer, computerized telephone switching system, Kevlar etc.

Many of the women inventors are not famous. If asked to name a woman inventor or her invention, most people would be unable to come up with a name. The display aims to focus on women inventors from all over the world and will present details of their lives, backgrounds and inventions through a visual medium.

183 SUNDARARAJAN, ASHA (DHIRYAVEER, 8TH ROAD JYPE, JUHU **MUMBAI**). DISCORVERY DOME BRINGING SPACE DOWN TO EARTH .

Students are fascinated by the cosmos and topics such as star birth, star death, and black holes. But they rarely have an opportunity to explore that interest as the school curriculum does not typically address these topics. The astronomy programs, Afterschool Universe and Discovery Dome was developed to fill this niche as the school years are a critical time in the development of attitudes about science and career options. By offering astronomy programming in out-of-school-time, where schedules are less constrained, we can engage students in science and keep them interested.

Disvocery Dome e-Planetarium®, is led by Prof. Patricia Reiff, Director of the Rice Space Institute at Rice University, Houston, Texas. The company was formed as a way to market shows, software, and planetarium technology created by the Immersive Earth project and its partners. The Immersive Earth project is a partnership between Houston Museum of Natural Science, Rice University, Carnegie Museum of Natural

History, HomeRun Pictures, Elumenati, and Sky-Skan Inc. This partnership was made possible from the "Immersive Earth", a five-year, NASA REASoN funded project that brings together five museums, two universities, and three companies to create and distribute full-dome digital planetarium shows and software.

From the six original sites, the Discovery Dome network is now nearing 100 installations around the world. DiscoveryDome India, a unit of HatTrick EdVentures Pvt. Ltd., is the Indian affiliate of DiscoveryDome, USA. Our focus is on the use of multi-media and planetarium immersive learning environments that display breathtaking content, which makes astronomy and space sciences come alive to adults and children alike. In addition, our founder, Ms. Asha Sundararajan trained at NASA Goddard Space Flight Center in the Afterschool Universe Program.

Our programmes:

A typical 3-hour half-day at a school or other venues comprises of 4 shows, a 6-hour full day comprises of 9 shows, with each show ranging from 25 minutes to 35 minutes, excluding introduction and review. In addition to the shows, we will have 8 laptops running simulation software that the audience, adults or children, can experiment with by travelling though the different parts of the cosmos at differing speeds. The selections of shows include Black holes, Ultimate Universe, Future Moon, Saturn the Ring World, Secrets of a Cardboard Box, Force 5, and Earth's Wild Ride. The descriptions and a preview of the shows are available on www.discoverydome.in

184 SHOME, SAURAV NATARAJAN, CHITRA (Homi Bhabha Centre for Science Education, **Mumbai**.). ENERGY AND ENVIRONMENT

The exhibit will give a brief outline of a course conducted on "Energy and Environment" with the students of Class VIII from an English Medium School (CBSE) in HBCSE. The course was structured mainly to explore students understanding on energy, environment, and energy-environmental issues. A large number of activities like responding activity sheets, poster making, Drawing, essay writing on imaginary situation, role play, survey, graph plotting, writing draft recommendation, experimentsetc was performed with students to have an wide and diverse idea of
students on the topics. The course was conducted in 8 contact sessions over a period of 15 days. Based on the students response in various activities a set of structured lectures were delivered to discuss the concepts, issues in the classroom.

The course was structured with a sequence of activities and teaching-learning tools. The sequence is not conclusive in nature but provides a valuable insight in structuring the course on the topic. The
Experience and findings of the course has been documented in various papers. The exhibition will mainly focus on the rational behind the structure of the course and its sequence of activities. It will also suggest the possible areas of improvements in this existing sequence.

185 YADAV, RANJANA (Homi Bhabha Centre for Science Education, TIFRMankhurd, Mumbai 400088). PESTICIDE LEVELS IN COMMON FRUITS AND VEGETABLES: IMPLICATIONS FOR CONTENT AND ACTIVITIES IN SCHOOL EDUCATION

The Indian population mostly relies for its food as well as other purposes like gum, cotton, etc. on the country's annual agricultural produce. Tracing historical developments in our agriculture-based economy, one clearly notices a paradigm shift from organic based subsistence farming to farming practices intensive in inorganic inputs somewhere around the introduction of green revolution. Situated in the context of these developments, the poster aims to highlight two aspects: (a) the effect of pesticides their on the physical and living environments and (b) the consequences of increasing plastics use in food packaging for the environment and human health.

This poster, based on the author's M.Sc. Project (Yadav, 2009), discusses some of the ill-effects of pesticides, in particular with regard to their use in growing and preservation of vegetables and fruits, on consumers of food. It suggests that these effects can be minimised through education that includes sensitizes people about the avoidance of pesticides and plastics in everyday use, and exposes students to activities in organic farming. This will help children realize the power of sustainable practices. Engaging in such practices students will also gain varied skills and knowledge that form a part not only farming related practices, but also sustainable life styles.

The present farming practices depend on extensive and uncontrolled use of pesticides. The annual requirement of pesticides in India is about 60,000 tonnes (Ref.Wikipedia, 2009). Insecticides account for 70% of total pesticides used in India. There has been a realisation, at least in some quarters in the country, of the innumerable counter productive effects of pesticide use. One of these is the resistance of pests to farm chemicals. Besides, persistence of agrochemicals in the environment through contamination of food and feed
sets in a series of undesirable effects. Heavy use of pesticides leads to bio-accumulation, and bio-magnification. Bio-accumulation is accumulation of pesticides in tissues organisms, while bio-magnification is incremental concentration of pesticides moving higher along the food chain.

Rachel Carson's book, "The Silent Spring", written several decades ago, has vividly described the effects of pesticides on the environment. We are still to put in place measures that could limit the use of pesticides and its entry into vegetables and fruits and ensure safe food production. Vegetables and fruits are the most common sources of pesticide entry into human bodies. Hence, assessing the diversity and the concentration of pesticides in some common vegetables and fruits in a local market would give an estimate of the potential threat from pesticides. The first case study, one of the empirical works of the researcher is a step in the direction.

The study was designed to monitor the presence of pesticides in some of the common vegetables and fruits: cabbage, onion and tomato and grapes. These were collected from the open market, retail outlets and in the form of packaged materials from the region surrounding Pune. The study adapted the method for multi-residue analysis used for grapes is validated by Banerjee et al. (2008). The analysis identified pesticide residues in vegetables and fruits using Gas Chromatography Mass Spectrometry (GCMS) and Liquid Chromatography Mass Spectrometry (LCMS).

Grapes showed the highest content and diversity of pesticides, which included Carbendazim, Flisilazole, Mathomyl, Omethoate, Dimethoate, Thiophenate-methyl and Profenophos. The second highest range of pesticides were found in Cabbage, which had 3 samples containing Captan and one with Bisphenol-A.

One of the unexpected findings was the presence of Bisphenol-A in all market samples of onions and two samples of tomatoes. Bisphenol-A is a monomer of plastics which leaches into tissues and has an estrogen-mimicking effect. This interferes with hormone levels and cell signaling systems. Long-term exposure may pose the risk of several health hazards, including breast cancer and uterine fibroids in women, and prostate cancer and decreased sperm counts in men. Even infants and adolescents may face behavioral problems such as hyperactivity or an early onset of puberty. The presence of this chemical can be attributed to the low quality polyethylene packaging, used for these edible items. The occurrence of Bisphenol-A draws our attention to the often unnoticed consequences of plastics in our everyday use. Hence, the urgent need for safer and economically viable options for packaging such as wooden and caruboard boxes, paper bags and cloth material.

The ill-effects of non-sustainable resources like plastics and pesticides are discussed in the context of present agricultural practices. Plastics and pesticides, the two deleterious agents of pollution often studied in isolation, are here known to have a combined effect. In the light of these findings, the potential of alternative organic farming practices are discussed. Such reforms have been inspiring a lot of reforms not just in agriculture but also in integrating such practices as a context in innovative curricula. Finally, the poster proposes that there is an immense potential for integrating organic farming practices within the

realm of teaching-learning.

186 VALIMBE, PRERNA; RASHMI And MANGAL, GRAM (Homi Bhabha Centre for Science Education, **Mumbai). GEOMETRIC THINKING**

Grammangal would like to present the following theory along with some work on the same done by the Grammangal students. Geometry has so far been given a very step motherly treatment in the school teaching and learning process. It is very important that this part of the maths content to be taken up more seriously. We are presenting a small effort in that path. Grammangal has been implementing this theory by way of a varied array of activities pertaining to the first two level of the theory, with a small group of children. A theoretical presentation of the theory along with some samples of the children's work can be displayed during the exhibition.
The theory is as follows.

The Van Hiele theory of Geometric thinking

The Van Hiele theory indicates that effective learning of Geometry takes place when students actively experience the objects of study in appropriate contexts, and when they engage in discussion and reflection. According to the theory, using lecture and memorization as the main methods of instruction will not lead to effective learning. Teachers should provide their students with appropriate experiences and the opportunities to discuss them. Teachers can assess their students' levels of thought and provide instruction at those levels. The teacher should provide experiences organized according to the phases of learning to develop each successive level of understanding.

There are four levels, which are sequential and hierarchical. They are:

***Level 1 (Visualization)*:** Students recognize figures by appearance alone, often by comparing them to a known prototype. The properties of a figure are not perceived. At this level, students make decisions based on perception, not reasoning.

***Level 2 (Analysis)*:** Students see figures as collections of properties. They can recognize and name properties of geometric figures, but they do not see relationships between these properties. When describing an object, a student operating at this level might list all the properties the student knows, but not discern which properties are necessary and which are sufficient to describe the object.

***Level 3 (Abstraction)*:** Students perceive relationships between properties and between figures. At this level, students can create meaningful definitions and give informal arguments to justify their reasoning. Logical implications and class inclusions, such as squares being a type of rectangle, are understood. The role and significance of formal deduction, however, is not understood.

***Level 4 (Deduction)*:** Students can construct proofs, understand the role of axioms and definitions, and know the meaning of necessary and sufficient conditions. At this level, students should be able to construct proofs such as those typically found in a high school geometry class.

According to the van Hieles, a student progresses through each level of thought as a result of instruction that is organized into five phases of learning. The phases are described below.

Information: Through discussion, the teacher identifies what students already know about a topic and the students become oriented to the new topic.

Guided orientation: Students explore the objects of instruction in carefully structured tasks such as folding, measuring, or constructing. The teacher ensures that students explore specific concepts.

Explicitation: Students describe what they have learned about the topic in their own words. The teacher introduces relevant mathematical terms.

Free Orientation: Students apply the relationships they are learning to solve problems and investigate more open-ended tasks.

Integration: Students summarize and integrate what they have learned, developing a new network of objects and relations.
particular topic.

Various Activities of the theory have been developed and are being used and simultaneously modified as needed in the classroom context. A clear hierarchy or trajectory of the same is yet to be formalised. It is still in the process.

AUTHOR INDEX

PLENARY AND PYBLIC LECTURES

187 NATARAJAN, CHITRA (Homi Bhabha Centre for Science Education, TIFR, V.N. Purv Marg, Mankhurd, Mumbai400088). PLACING SCIENCE AND TECHNOLOGY WITHIN A HOLISTIC GENERAL EDUCATION.

The crisis in the present state of science and science education in India has been the subject of recent news items and talks given by eminent scientists and thinkers. Indicators of this crisis are both performance and policy related. India's world ranking in publications of scientific research slipped from being 8th in the world in the 1980's to 21st in the current decade. Either as a cause or as a covariant, the funding for Science is also seen to be waning: the already inadequate national R&D expenditure as a proportion of GDP has declined between 2000-01 and 2004-05.

Comparisons with China further exacerbate the perception of the crisis. China's R&D expenditure as percentage of GDP in 2000-02 was 1.23 when the corresponding funding for India was only 0.8. Besides, according to a World Bank Study titled "India and the Knowledge Economy", there are 99 researchers in R&D per million population in India compared to 584 in China. Science and engineering enrolment ratio as a percentage of tertiary level enrolments is 25 for India and 43 for China.

The underdevelopment of human resources in science and technology is seen to be the cause of the incapacity to generate new knowledge and innovations. In his speech at the launch of Broadband corDECT system on 30 October 2005, the then Hon'ble minister Dayanidhi Maran pointed out that India had a strong R&D infrastructure, but India's share of global patenting wassmall. He surmised that India was "weak on turning its research into profitable applications."

Comparisons with China are relevant in highlighting our performance potential. The paths of reformation that the nation adopts, in educational as well as other systems, will depend on existing systems and diversities as well as and importantly on a shared vision of the future Indian society. Even amidst the cacophony of doomsday predictions and fixing of faults, people of the country need to generate short term and longer term goals founded on a shared vision of a future India.

There is no doubt that both science and technology will continue to play an important role in the visions and goals of the country, much as they have done since independence. However, the country formulated its Science Policy over a decade after independence and the need for a separate Technology Policy was recognised only after three more decades. The impact of these policies on science and technology (S&T) has been largely reactive rather than responsive. Education reacted by attempting to catch up with shortfalls of personnel and skills needed for existing industry instead of responding with reformations to build a nation of creative people.

India has 157 scientists and engineers per million population, while Sri Lanka has 200. In 1985, annual publications by Scientists registered in the Science Citation Index (SCI) of Institute of Scientific Information, Philadelphia, USA was 11322 for India. which was thrice that for China (3238). But during 2002-04, publications by Indians had fallen marginally to 12127, while for China this had increased many fold to 22061. India ranks 24 among 192 scientifically proficient nations according to the Rand Corporation Classification. And it seems that we are almost proud to be there! Even these contributions come largely from Space research, IT, Pharma industry and biotechnology.

S&T education for self-reliance over a few decades tacitly assumed that scientists working in existing laboratories, along with engineers and technologists would search out "imported" technologies and replace them with "indigenous" ones. There is no doubt that this yielded results. Unfortunately it also gave rise to a generation of S&T personnel content with reproducing or tweaking technologies existing

elsewhere. In the last decade, as the nation has moved inevitably towards increasing globalisation, S&T education in the country is woefully inadequate to meet the innovation needs of a changing society.

How do we generate shared visions of a future for the country? It is heartening that at least among the Indian school students there is awe and admiration for science and scientists (Chunawala & Ladage, 1998). And school science education might well be the context for laying the foundations of a society that can generate powerful shared visions.

Science: a favoured school subject

Oblivious to the sense of crisis conveyed in the media about science, the interest and motivation for science and regard for scientists among students at the school level has remained high. A study of middle school students' ideas about science and scientists (Chunawala & Ladage, 1998) revealed that students hold a very positive image of science and scientists; primarily in terms of progress of the nation and self advancement. The first India Science Report (National Council of Applied Economic Research, 2005) commissioned by the Indian National Science Academy indicates that the proportion of students that rate subjects like Physics, Chemistry, and Biology as the favoured subjects in Classes 6 to 8, triples at the +2 level (in Classes 11 and 12). 'Interest in science subjects' is the foremost reason for about 67% of Class 11 and 12 students to opt for admission in science; technology, engineering and medicine being the hot favourites.

Not as dramatic, but also noteworthy, is the fact that the number as well as proportion of students enrolling for science education (relative to other streams) at the graduate level and higher rose from 29% in 1995-96 to 31% in 2000-01. An increase was also seen in the proportion of women studying science at post graduate level (39%) compared to graduation level (37%) but some decline occurred at the level of Ph.D. (Indian National Science Academy, 2004).

Unmet aspirations of science students

The dream of an exciting and economically viable career in science begins to falter as students enter the portals of colleges and universities. An overwhelming majority of B.Sc. students, even those with considerable talent, goes through science education without any direction or serious motivation. Most students orient themselves to the immediate and imminent examinations. Generalised B.Sc. degrees foreclose employment avenues. Lacking application skills in any area of work, the students armed with a bachelor's degree in science have low morale and lower self worth. They feel resigned to working in areas more economically viable, even if far removed from science and technology. These could range from being cogs in the BPO wheel to selling soap. Their impressive designations of "customer care executive" or "sales executive" belie their gruelling schedules and often demeaning interactions with customers. What is worse, their self-worth is built upon the pay packet, which has little relation to the nature of work done, but depends more on the time of work; they have sold their souls to the mammon. They are minimally trained in soft skills and acquire few skills in the course of their work.

The situation is no brighter for the few, who manage to sustain their interest in science and enroll for post graduation. Of the 31% of the students who enrolled for science education at the graduate level and higher in 2000-01, only a little over 1% enrolled for Ph.D. There is low interest in pursuing pure science at higher level of education. Multiple inadequacies at all levels of education have failed the students.

School education generates a distorted view of science and misplaced aspirations about it. Any real learning is thwarted by examinations that demand memorisation. With a toolbox devoid of knowledge, skill sets, articulation and wit, students are disadvantaged even before they set out on a research career in science. Besides, the low quality of infrastructure and inputs at the tertiary level systematically decimate students' motivation for science learning evident at the school level.

There is a need to sustain the positive feelings towards science that school students have. At the same time, the distorted view of science transmitted through education needs to be corrected. It is often viewed either as merely involving memorisation of facts and procedures or as a domain meant for the super

performers. Besides the current unbalanced ecology of school education that tends to exaggerate the importance of some subjects like science, information and communication technologies, etc. at the cost of others like the arts and crafts or the humanities, needs to be addressed. We need to formulate a more holistic general education at least at the school level.

Towards a holistic general education

There are several ways of perceiving and interpreting the world. These are included in education as humanities, the arts and literature, design and technology, engineering and science. Science may well be the most efficient and reliable means of generating knowledge about the world, but it is neither sufficient nor adequate to satisfy the physiological and psychological needs of a human life time, nor the social needs of the human species. Education is as much about learning concepts and procedures, as it is about letting imaginations soar, developing artistic sensibilities and designing humane environments with concern for sustainability of the human race and the environment. Education is about knowing and using with wisdom the laws and patterns of the animate and inanimate world, including humans and the worlds created by them, the arts and the artefacts.

Even as they probe the smallest and the vastest in the universe, scientists, much like Shelly's skylark, need to have their feet on terra firma. Human lives are influenced as much by the social and political systems as they are by the laws of science; as much by beauty and emotions of compassion and desires as by rational thought and logical reasoning.

Science, though an important component of holistic education, is by no means the only way of "seeing" the world. The sciences, the humanities and the arts need to be viewed as Complimentary aspects of general education that together form the broad foundations that offer students wide choices for further learning. Language development, quantitative and visuospatial reasoning skills, social skills of communication, creativity and manual skills need to become essential components of meaningful and effective learning. In fact, even for effective learning of science, school education must view these aspects within all subjects.

School students need to engage in exploring the world through all manner of activities. On the one hand, the activities could lead from the context of life and everyday living, and inspire them to go well beyond their immediate concerns. Activities could be structured to build essential skills and could address the understanding of concepts and procedures.

The National Curriculum Framework 2005 was a step in the direction of examining school education and bringing it in consonance with current research in student learning. The position paper of the National Focus Group on Teaching of Science states that, "Schools should give much greater emphasis on co-curricular and extra-curricular elements aimed at stimulating investigative ability, inventiveness and creativity, even if these elements are not part of the external examination system." This is an unsure step towards holistic general education. However, it encourages thinking by teachers and students, which are the key elements that can be strengthened to promote meaningful learning.

Making a place for design and technology in school education

School education needs to provide students with ample opportunities to work with their hands. Educationist are unlikely to oppose this idea, though they may differ with regard to the reasons for its inclusion in general education. The educationist may be inspired by the philosophies of Gandhi or Tagore, Dewey or Aurobindo. However, the idea of students engaging in hands-on work is often lost in its translation to the school curriculum, syllabus, classroom practice and assessment. It often ends up as recipes and procedures that students must observe and reproduce. When it is not about doing experiments with foretold conclusions, it is at best about learning skills by drill and practice in an obsolete or irrelevant context.

Vocational education, considered as the space within education for hands-on work, suffers from a shortsighted syllabus, and creates the totally replaceable cogs for the industrial wheel. Learning procedures and facts are of limited use to citizens in coping with a fast changing world. At best such an education produces followers, not leaders, in a scenario that demands "innovation" not mere "indigenisation". Today, even labour needs to be continually re-skilled to survive in an environment that calls for creativity, innovation and critical thinking.

Introduction of work-related curricula at the secondary school level since the 1960s and again in the 1980's in response to the Kothari Commission reports has raised important questions. Should vocational education in schools be promoted to support industry and its profits? Should we be teaching students facts, procedures and recipes in the name of preparing them for the world of work? Instead, should we not be educating young people to live in and deal with an increasingly complex technological world? Should we not encourage students to critically examine the socio-cultural, political, ethical and emotional implications of technology? This is a good place and time to revisit the arguments of two of India's educational philosophers.

Gurudev and the Mahatma

"Our education has got to be revolutionised. The brain must be educated through the hand. If I were a poet, I could write poetry on the possibilities of the five fingers. Why should you think that the mind is everything and the hands and feet nothing? Those who do not train their hands, who go through the ordinary rut of education, lack 'music' in their life. All their faculties are not trained..." Mahatma Gandhi to teachers,18-2-'39 (Gandhi, 1994)

Imagine the scenario: An electrician and a plumber walk into an affordable house-under construction, the owners articulate their needs, and service providers end up giving them switches most convenient to use and easily maintainable plumbing that gets water-on-tap. Surely the owners and the service providers must have all had an education in design. Imagine again that you are visiting a metropolis and find it well laid-out. Everything seems to have been *designed* to work: pedestrian walk ways, biking routes, bus routes, crossings and stops, trains, stations, airports, all artefacts and organisations, schools, and curricula. You talk to a spectrum of people from different walks of life and learn that the planning has been participatory and carried out with insight. The general education of all people in the metropolis must have included courses on design and technology. And the education of the skilled workers perfected and built upon what they had learned at school. This situation in India, unfortunately, is a long way coming.

The plea for inclusion of technology related aspects in general education was made about a century ago by two of the leading educational philosophers of modern India: Mohandas Karamchand Gandhi and Rabindranath Tagore, known respectively as Mahatma and Gurudev. It was Tagore, who first referred to Gandhi as Mahatma (the Sage) in 1915. Gandhi in turn gave Tagore the sobriquet of Gurudev (the great teacher) referring not just to his initiatives in building a model educational institution, Shantiniketan, but indicating that he was teacher to the whole world. Gandhi in his Buniyadi Taleem (Basic Education) and later in Nayee Taleem (New Education), addressed education of students in all subjects through productive engagement in crafts in general, and specifically, through spinning and weaving.

The Mahatma and education for self-reliance

Gandhi in his Buniyadi Taleem and later in Nayee Taleem, addressed education of students in all subjects through productive engagement in crafts in general, and specifically, through spinning and weaving. Addressing the National Education Conference held under his leadership at Wardha, Maharashtra, in October 1937, Mahatma Gandhi stated:

"What I am going to place before you today is not about a vocation that is going to be imparted alongside education. Now, I wish to say that whatever is taught to children, all of it should be taught necessarily through the medium of a trade or a handicraft. You may argue that, during the middle age, children were taught only trades (crafts) in our country. While I agree with this contention, but the proposition of imparting the whole of education through the medium of trades (crafts) was not considered in those days. A trade (craft) was taught only from the standpoint of a trade (craft). We aim at developing the intellect also

with the aid of a trade or a handicraft . . . . . Therefore, it is my submission that, instead of merely teaching a trade or a handicraft, we may as well educate the children entirely through them. Look at takli (spindle) itself, for instance. The lesson of this takli will be the first lesson of our students through which they would be able to learn a substantial part of the history of cotton, Lancashire and the British empire. . . . . How does this takli work? What is its utility? And what are the strengths that lie within it? Thus the child learns all this in the midst of play. Through this he also acquires some knowledge of mathematics. When he is asked to count the number of cotton threads on takli and he is asked to report how many did he spin, it becomes possible to acquaint him step by step with good deal of mathematical knowledge through this process. And the beauty is that none of this becomes even a slight burden on his mind. The learner does not even become aware that he is learning. While playing around and singing, he keeps on turning his takli and from this itself he learns a great deal." *Excerpted from the address at the Wardha Education Conference, 22 October 1937, Translated from Hindi, Annexure I, pp. vii-viii,* (in NFG-W&E, 2007)

Two years later, while answering questions raised by teachers at the Wardha education Conference, he elaborated that the teacher had to be both knowledgeable in the subjects as well as an expert in the conceptual and procedural knowledge and skills of the craft. His educational model emphasized learning skills by prescriptions and economic productivity. The Wardha Educational Conference held in October 1937 passed a resolution to provide free and compulsory education every child of 7 to 14 years of age. The medium of instruction would be the mother tongue, the process of education throughout this period should centre around some orm of manual productive work, and all the other abilities to be developed should be integrally related to the central handicraft chosen, with due regard to the environment of the child. This system of education would gradually be able to cover the remuneration of the teachers. The following passage from his letter to Narandas Gandhi on August 10, 1937 has some elaboration of this idea.

For the all-round development of boys and girls all training should so far as possible be given through a profit-yielding vocation. In other words vocations should serve a double purpose—to enable the pupil to pay for his tuition through the products of his labour and at the same time to develop the whole man or woman in him or her through the vocation learnt at school. Land, buildings and equipment are not intended to be covered by the proceeds of the pupil's labour. All the processes of cotton, wool and silk, commencing from gathering, cleaning, ginning (in the case of cotton), carding, spinning, dyeing, sizing, warp-making, double-twisting, designing and weaving, embroidery, tailoring, paper-making, cutting, bookbinding, cabinetmaking, toy-making, gur-making are undoubtedly occupations that can easily be learnt and handled without much capital outlay. This primary education should equip boys and girls to earn their bread, by the State guaranteeing employment in the vocations learnt or by buying their manufactures at prices fixed by the State. (Gandhi, 1994)

Though this was the inspiration for post-independent educational programmes, it was perceived as impractical and a mere caricature of the idea was implemented. Supposedly to promote the Gandhian pedagogy of integrating the 'world of work' with the 'world of knowledge', the Central Advisory Board on Education made the following observations on the then proposed education framework:

"Basic (Primary and Middle) education, envisaged by the Central Advisory Board, embodies many of the educational ideas contained in the original Wardha scheme, though it differs from it in certain important particulars... So far as possible the whole of the curriculum will be harmonised with this general conception... The Board, however, are unable to endorse the view that education at any stage and particularly in the lowest stages can or should be expected to pay for itself through the sale of articles produced by the pupils. The most which can be expected in this respect is that sales should cover the cost of the additional materials and equipment required for practical work." *Report by the CABE, January 1944, Chapter 1, Section 3* (in NFG-W&E, 2007)

Kothari Commission recommendations that resulted in the National Policy on Education in 1968 (GOI, 1968) ended up vocationalising general education and making vocational education too generic and irrelevant for employment. The education bore no resemblance whatsoever to Gandhian model of holistic education through productive engagement in crafts. The Wardha model had been completely derailed. The

main problems in applying the model nationwide came from its impracticality at two levels. Neither the educationists nor the parents were willing to commit to the economic sustainability envisaged for craft teaching through local generation of funds by selling the products made by students. A major stumbling block was the mastery over subjects as well as crafts required of teachers. Where could such teachers be found? How could they be trained in the large numbers needed in a short time for an ever increasing population of students entering school? Besides, the geographic and cultural diversity in the country required flexibility in the choice of craft at school level. While Gandhi himself had built in these flexibilities, there were no guidelines for reaching equitable standards of education through different crafts and their traditions. Gandhi's model was based on his perceived urgent need at the time to provide economically productive engagement to the majority of starving villagers, while upholding dignity of labour and local self-sufficiency.

Gurudev and creativity in education

The quintessential poet philosopher, Rabindranath Tagore, on the other hand, had a more comprehensive educational programme. He believed that mother tongue must be the only medium of instruction; nature was the richest centre of learning, and that creative activities, specifically the arts, played a central role in the process of education. He opposed Gandhi's model of charkha-based education at a fundamental level.

"... a man can be stunted by big machines, the danger of his being stunted by small machines must not be lost sight of" (Prabhu and Kelekar, 1961, page 65) for, "the performance of petty routine duties... imparts skills to the limbs of the man who is a bondsman, whose labour is drudgery; but it kills the mind of a man who is a doer, whose work is creation" (page 85) Further, "... the depths of my mind have not been moved by the charkha agitation... (and) there are others who are in the same plight as myself – though it is difficult to find them all out. For even where hands are reluctant to work the spindle, mouths are all the more busy spinning its praises... I am afraid of a blind faith on a very large scale in the charkha in the country which is so liable to succumb to the lure of short cuts when pointed out by personality about whose moral earnestness they can have no doubt." (page 87-88) "And further by doing the same thing day after day mechanical skill may be acquired; but the mind, like a mill turning bullock will be kept going round and round a narrow range of habit" (page 91).

There were several debates on education, specially on the advocacy of the *charkha* between the poet and the sage. Tagore objected to the turning of the charkha as a form of ritual (Giri, 2002).

Reconciling self-reliance with creativity

There is a lament that our school curricula give scant regard to the nation's cultural heritage of technology production and to the empowerment of its present populace with such production (Kothari, 2001). The curricula have been aimed at the creation of "specialists", who can "deal" with technologies produced elsewhere. People who have historically produced local expertise to solve contextual problems are now trained by the education system to seek and adapt technologies innovated elsewhere: local producers have turned foragers in the global arena, and suppressed local production of technology. Our historical location has changed much from Gandhian times. Supposedly efficient technologies from the industrialised world replace local appropriate technologies. The following exchange of ideas between Tagore and Gandhi quoted by Kapoor (1999) might as well refer to such familiar and current situations.

Tagore: "So if we are taught that in the pristine *charkha* we have exhausted all the means of spinning thread, we shall not gain the full favour of Vishnu. Neither will his spouse Lakshmi smile on us. When we forget that science is spreading the domain of Vishnu's *chakra,* those who have honoured the discus-bearer to better purpose will spread their dominion over us. If we are willfully blind to the grand vision of whirling forces, which science has revealed, the *charkha* will cease to have any message for us. The hum of the spinning wheel which once carried us so long a distance on the path of wealth, will no longer talk to us of progress."

Gandhi: "The poet lives in a magnificent world of his own creation — his world of ideas. I am a slave of somebody else's creation — the spinning wheel. The poet makes his *gopis* dance to the tune of his flute. I wander after my beloved Sita, the *charkha,* and seek to deliver her from the ten-headed monster from Japan, Manchester, Paris, etc.,."

Both creativity and self-reliance have been used to justify the content of school education. Self-reliance at the individual and national levels have influenced content in the science subjects, and motivated the introduction of work education and other vocational subjects in general education.

While science is considered an important subject, vocationalisation has failed to find favour among students and parents. Creativity is often associated with the arts, while innovation has been completely sidelined, or left to the elite in higher education. School students are given scant opportunities for design or technological innovation. Schools teach not technology, but about technology; that too as application of scientific principles rather than as an endeavour in its own right. Students rarely, if ever, engage with technology.

Perhaps to make amends for the lack of hands-on activities in school science, National Children's Science Congress (NCSC), initiated in 1993, provides the children of 10 to 17 years from all over the country an opportunity to make projects based on different themes each year. Selected from district and state level competitions, about 500 children take part at the national level in the annual five day activities in December. Only about a third of the schools in most States and a small fraction of the students of these schools participate in these fairs. The potential innovators in the country do not have access to the knowledge and skills that aid innovation. The lack of opportunities in school curriculum for creativity and innovation is glaring in the light of a large proportion of the country's school student population of about 300 million dropping out well before Class X. Only a small fraction of those who pass out from school qualify to learn engineering, design or technology at the tertiary level. This situation is reflected in international reports on the country being dependent on adapting technology and rated low on significant technological innovations (UNESCO, 1998). On the other hand, the history of civilizations of the Indian subcontinent is notable for technological innovations.

In this context, how can one reconcile Gandhi's self-reliance principles envisioned in his educational model and iconised by the charkha, with Tagore's dream of unleashing the nation's individual and social creativity embodied in his conceptualisation of a school? General education for all students in design and technology seems to be the answer. Design and technology are organically linked. The former stands for innovation and creativity, while the latter is the very foundation of self-reliance, an aspect that India values, and one that has guided the country's science and technology policy decisions for decades.

Technology and Culture

Technology is a social endeavour, being inspired by human needs and owing its existence to the perceived fulfillment of such needs. Hence it is embodied in culture: in the artefacts as well as in the languages and actions that have evolved around them. From pre-history to the Space Age and beyond, all human settlements have "toyed" with technology. History of civilisations is replete with the technological achievements of human communities. The growing needs of humans and their quest for survival have certainly spurred the search for better ways of satisfying them, but so has basic human curiosity for new knowledge. Since the agricultural revolution over 10,000 years ago, humans have evolved culturally, and along with their cultures, have evolved their technologies (DeGregori, 1989). Architecture and town planning, metallurgy and sophisticated surgical tools, innovations in agricultural practices and implements, and several others indicate a rich heritage of technology in India (Kumar and Mahurkar, 2002).

Thus, technology's history is but a strand in the cultural history of humankind. Some cultures have used technology as a tool to dominate others. Concerns about inefficient use of resources and environmental mismanagement, has in recent times, been the focus of the discourse on the survival of human species. Through cultural evolution and early technology innovations, India is home to a vast human resource, capable of adaptive use of modern technologies. However, the country has been consistently rated low on significant technological innovations (UNESCO, 1998). This apparent paradox may be resolved in

as many ways as there are ideologies and their adherents. Colonisation, worldviews, social attitudes, political will, economic resources and education have all been implicated for the "differential" technological performance.

Any technological activity is task-centred and goal-directed and hence purposeful and focused. While the raison d'être of technology is to create purposeful change in the "made" world, one may well ask, echoing Marxist ideologies, "whose purpose" it is intended to serve. From a social constructivist paradigm of technology, Langdon Winner (Winner, 2002) argues that technologies have inherent political implications, and may be strongly compatible with specific social orders. Nuclear technologies tend to be centralised and authoritarian rather than egalitarian. A flyover may limit access to a beach to certain socio-economic groups. According to Winner, the political consequences of such technologies can be traced to their designs. Greatest latitude of choice exists at the very beginning, and this flexibility vanishes once initial commitments are made.

Design and technology involves making decisions, like which product or system will serve the purpose, how it will be made, who will make it, what materials will be used to make it, who it will serve best, what effect it will have on social and environmental systems, and so on. Development of technological competence involves continued use in activity, especially in "authentic" or "real" situations. Solving problems set in the real world initiates a variety of cognitive processes, including reasoning about purposes in relation to the resources and tools the situation affords (constraints). Cognitive content as well as processes depend on language, artefacts and tools of the culture (Nisbett et al, 2001). Language production, meaning making, discourse, tool use and tool making are all best understood as a dynamic interplay betweenindividuals and society at various levels of interaction.

People learn skills and the production of technology in the context of apprenticeship, a successful process that has evolved over time. The evolution of technology, like language, the other significant tool of culture, resembles human evolution, and dynamically feeds back into human evolution. Tools, and symbols are by themselves static. Humans use them and generate the dynamic process of technology. From the earliest stages of their evolution, technology and tools have involved ideas or "preconceptions" and a complex interaction between skills, ideas and materials.

Technology is located in the actions of persons and groups, and evolves in problem situations, which make sense within a historical context, including the past experiences of participants, as well as anticipated actions and events. Technology not only enables thought, intellectual processes and action, it also constrains processes and action. Using tools (and technology) in a certain manner implies adoption of a cultural belief system about how the tool is to be used. It is closely linked to identities and the construction of self.

Clearly then, it is essential for communities to negotiate the goals of technological activities to better serve their lives and sustenance. In all innovations, there can be winners and losers. The physical environment and its resources may be compromised. Within the technological activities of their community, it is important that all people learn to integrate values that can sustain natural resources and ensure socio-cultural equity (Natarajan, 2004). The survival of cultures is evidence that all cultures have the capability to visualise and redesign their environment in harmonious and aesthetic ways, or for purely functional purposes.

Engineering, technology and design education

As discussed above, technology is a basic human capability, much like language. It is the use of knowledge, skills, materials, tools and systems, as well as the creative process and values and judgements, to improve the quality of human lives. It uses science as well as other organized knowledge to achieve practical tasks. Engineering too uses a core knowledge of concepts, skills and procedures. However, engineering concepts are predominantly from science and mathematics. In the context of education, technology is generic, while engineering, is vocation specific with fields like mechanical, electrical, civil,

etc. Activities in both technology and engineering may be broadly viewed as having four, not necessarily distinct, stages: invention or research, design, construction or prototype making and final production of product(s) (Mitcham, 1994). While engineering emphasises the first three, technology focuses on the latter three.

Design, a core activity in both technology and engineering, connects the initial thought to the final product, whether prototype or mass produced. Design is "reified thought": it is through design that artefacts and their organisations come into being and evolve. Design can be understood both as a noun and a verb. Design, in a broad sense, is the bundle of techniques, skills and approaches that can be used to determine and make sense of the future character of the world of buildings, places, images and products. Handling change in a purposeful way is one of the main characteristics of design activity. Design is also the field in which handling of change and its outcomes are set.

Emphasis on design within technology education affords a space for critical debate about social, ethical and environmental dimensions. For individual and social survival, it is important to foresee the qualitative results of technological change. Consumers or users of design products and activities, when equipped with a broad range of skills and understanding in the realm of Design and Technology (**D&T**), can take better control of their own environment.

Design and cognition

Science and design address distinct spheres of human knowledge, use different cognitive tools of study, engage in diverse activities. The natural sciences are concerned with how things are, the nature of what exists. Scientific activity is a process of pattern recognition. While solving a scientific problem, the scientist is able, and often required, to suspend judgements and decisions until more is known about the problem. Design is concerned with how things ought to be. It is about inventing things of value which do not yet exist, a case of pattern synthesis. Science is analytic; design is constructive. (Gregory, 1966)

Design is about making things work better. It may be about designing fresh smelling textiles, or fashionable, functional and inexpensive clothes. It may be about making your locality beautiful and convenient, making an easily readable tour map that showcases your institution or city, or planning an emergency response system. Design is also about seeing the world in special ways; in creative ways; in designerly ways (Cross, 2007).

A central feature of design activity is the quick generation of a satisfactory solution, rather than any prolonged analysis of the problem. The scientist suspends judgements and decisions about the solution until the problem is known. In the case of design problems, all the necessary information is never available to the problem-solver: design problems are characteristically illdefined or ill-structured. The solution of such problems call for and sustain development in multiple modes of cognition. Designers use 'codes' that translate abstract requirements into oncrete objects. They use these codes to both 'read' and 'write' in 'object languages'. The concrete or iconic mode of cognition is an innate human ability. Proponents of situated cognition and followers of Bruner's ideas (Lave and Wenger, 1991) suggest that cognitive development is a continuous process of interaction between different modes of cognition, concrete/ iconic and formal/ symbolic, all of which can be developed to high levels. These are not merely a characteristic of a stage of development. There is a need for the development of such modes of cognition through general education.

A central feature of design activity is the quick generation of a satisfactory solution, rather than any prolonged analysis of the problem. This may be seen less as any intrinsic inadequacies of designers and their education, but more as a reflection of the nature of the kinds of problems designers tackle. The designer is constrained to produce a practicable result within a specific time limit. In the case of design problems, all the necessary information is never available to the problem-solver. Design problems are hence known to be ill-defined, ill-structured, or "wicked". Designers tend to attempt to define the limits of the problem and seek the nature of possible solutions. A challenging part of designing is to change the problem in order to find a solution. Planning, designing and inventing new things are characteristically ill-defined problems.

The natural sciences are concerned with how things are... design, on the other hand, is concerned with how things ought to be (Simon, 1969). Designing, unlike the scientific activity is a process of pattern synthesis, rather than pattern recognition. Designerly ways of knowing rest on the manipulation of non-verbal codes in the material culture that facilitate the constructive, solution-focused thinking of the designer, in the same way that verbal and
numerical codes facilitate analytic, problem-focused thinking.

Language of design and technology

A concrete language is essential to technological innovations. As quoted in Kimbell et al (1996), there is a critical and recursive (iterative) relationship between expression of ideas and the development of ideas among school students. "... the act of expression pushes ideas forward. By the same token, the additional clarity that this throws on the idea enables the originator to think more deeply about it, which further extends the possibilities in the idea. Concrete expression (by whatever means) is therefore not merely something that allows to see the designer's ideas, it is something without which the designer is unable to be clear what the ideas are." (p 23-24) Technology education in school provides students the opportunities for learning the language of design and technology through cognitive modelling. This would involve reading about the ideas in technological artefacts and writing about it, perhaps with helpful diagrams and sketches. One might even question its validity in ensuring technological literacy, for it has severe limitations when it comes to complex ideas and patterns. It is only through the expression of these in the form of models and drawings that the ideas can be clarified.

Just as the existence of a language is no guarantee of its fluent use, a complex language of technology at people's disposal is no guarantee of its creative use. There is a world of difference between using the language to understand and respond, and using it to create new technology. Innovation calls for higher ability in the use of language, besides a sense of ownership over the language of technology. In this sense, it parallels the problems of multilingual education. In fact, in the multi-cultural settings prevalent in India, the language of technology can and must evolve within the classrooms. Its evolution needs to be negotiated by the taught, with culture-sensitive teachers capable of evolving "appropriate" technical vocabulary.

To acquire capability in design and technology pupils need to master the knowledge and understanding not only of key concepts within the ambit of technology (like "mechanisms" and "product quality"), but also concepts from other disciplines, such as science (electricity), or art (use of 'visual elements'). They must also have the ability to combine these within a design task by employing a range of process skills. Procedural ability will include an understanding of how to go about designing and making and will include process skills such as specifying outcomes, modelling ideas and evaluating products.

Design and technology activities provide the discourse space and cultural environment that support the use and learning of technology-specific language. Activities in this domain involve description through technical terms, using images and symbols, through sketching, technical drawing, diagrams and photographs. Signs and symbols are used for representing an idea, modifying it and communicating with peers. In design and technology activities, students can be encouraged to discuss materials, shapes and sizes and their affordances, read and write about technological artefacts. Communicating about design needs nonverbal modes, graphic images like drawings, diagrams and sketches as well as the use of mental imagery.

Solomon and Hall (1996) have emphasized the purpose and importance of language in technology education: 'Language is vital for almost all learning, for describing shapes, anchoring concepts, and making the tacit articulated.....' (p. 275). External representations play a special role in internal cognition (Langer, 1962 in Kimbell et al, 1996; Vygotsky, 1966). The history of engineering drawings demonstrates that the modelling methods available to designers affect the potential content of their thoughts (Baynes 1992). Yet, communication remains one of the most neglected components of technology education.

Teaching design and technology to primary and pre-school students can help to promote creative, critical and playful thinking. It helps children internalise and develop their imagination using tools of

thought, which evolve as they are used in playful, innovative ways (Parker-Rees, 1997; Senesi, 1998, 1998a, 2000, 2000a). Evidences of design thinking have been noted among children between 3 and 9 years of age (Senesi, 1999; Senesi, 2000; Fleer, 2000, Hope, 2000) as well as among 11 to 14 years old middle school students (MacDonald and Gustafson, 2004, Khunyakari, 2008).

D&T in general education

Several educationally important aspects that characterise design thinking. Including the development of psycho-motor skills and practical aspects of technology, there are three main areas of justification for D&T in general education.

First, D&T develops abilities in solving real world problems, which are often ill-defined and provides authentic contexts for constructive thinking, distinct from inductive and deductive reasoning. Second, D&T sustains development in multiple modes of cognition through its contextual use of codes and object languages. An education for the development for constructive thinking while working with designing codes has been for long neglected. This can perhaps, be traced to the dominance of the cultures of the sciences and the humanities, and the dominance of the stage theories of cognitive development. The third justification for D&T in general education comes from its integration of episteme (knowledge), techné (skill), and phronesis (practical wisdom) (Dunne, 1993).

Over and above the verbal, numerical and literary modes of thinking and communicating that most school subjects aim to develop, as discussed in Section VI, D&T develops multiple modes, including nonverbal ones, graphic images like drawings, diagrams and sketches as well as the use of mental imagery. According to French (1979), development of nonverbal thinking is perhaps the principal justification for design in general education: "It is in strengthening and uniting the entire nonverbal education of the child, and in its improvement of the range of acuity of his (sic) thinking, that the prime justification of the teaching of design in schools should be sought, not in preparing for career or leisure, nor in training knowledgeable consumers, valuable as these aspects may be." The goals of D&T education are thus more fundamental than those of education in the arts or vocational education.

Doing technology entails defining the problem, generating solution strategies (ideas), making models, applying constraints, selecting appropriate model, evaluating (critical thinking) and modifying the model before implementing. Designing happens in real-world contexts, for contemporary purposes, to satisfy demands of real users, and hence takes account of contemporary knowledge, tools, values and aesthetics in a given society. One may argue that the design itself is constrained by the collective knowledge of concepts and skills among the designers. However, the envelope of such knowledge is expanded by the very problem to be solved that demands that designers learn about materials and tools, and acquire the skills and techniques to arrive at a solution that will satisfy the purpose and the user.

D&T education is in contrast to technical or vocational education that is procedural rather than designed and low in academic content. The latter emphasizes skill acquisition by following a given prescription that is required to be guided neither by negotiated nor contemporary needs. It easily becomes obsolete, needing frequent re-skilling. For locally appropriate innovation, D&Teducation, starting at the school level, must include knowledge, critical thinking about the activity and its consequences, as well as sensitivity to issues of equity and sustainability.

D&T activities in school education need to involve multidisciplinary perspectives, broad based skills, and multiple modes of expression. School education that merely addresses knowledge about technology can stifle innovation. D&T education has a scope wider than either applied science, vocational education or work experience, and it transcends science for its disciplinary grounding.

There can be several facets to technology education at the school level depending on the stakeholders, who support it. As an economic instrument, technology education contributes to national wealth creation. It helps sustainable development by making economic growth compatible with environmental protection. Technology education has hitherto served to enhance the professional image of technology or engineering; improving its standing in society. This hassled to a traditional view of technology driven by science, which

has been the justification for teaching technology as applied science in Indian schools. But historically, technology has often led science. Science can provide the resources/ means for technological advances. A D&T education needs to include a metaphoric understanding of technological activities for all people, not only for the practitioners and professionals. Hence, it is time that the discipline goes beyond being the exclusive domain of higher education and enters the portals of schools and empowers students from a very young age.

The last few decades have seen a resurgence of interest in technology education around the world. The content, skills, and processes encompassing technology education are all being examined. Common to most curricular proposals is the importance of the design process as inherent to an education in technology (Vries, 2006). Even so, the number of different ways of introducing design in school curricula are as many as there are educational policy makers in the world. They include several country specific approaches and priorities, and are based on individual and cultural understanding of what technology means.

Layton discusses the possible pragmatic goals for choosing to teach technology (Layton, 1994). Some countries like India approach technology as application of science. Some include design for furthering scientific understanding, as does HBCSE's science curriculum. Others, like Israel, include projects in science and technology (S&T), while some like Australia emphasize S&T for environmental sustainability. The curriculum in the USA specifies engineering design and seeks to integrate science, technology, engineering and mathematics (STEM). One of the earliest to implement a D&T curriculum, England has argued for prominence of design in technology education with making (Kimbell et al, 1996) and without making (Barlex and Trebell, 2007). Some countries like New Zealand emphasise technology and its processes, while Hong Kongfocuses on ICT. Taiwan and China have curricular goals of promoting creativity andinnovation. Sweden, Norway and Finland emphasise technique and crafts.

Collaboration in D&T education

The competitive environment of the Indian classroom, with a greater than optimal number ofstudents taught by the transmission/ lecturing mode, leaves little room for collaboration and peer interaction among students. According to Bruner, classrooms are communities of mutual learners, where understanding is fostered through collaboration and discussion. (Bruner, 1996) Technology units, that include design and making tasks in groups, provide opportunities for collaboration that may result in the creation of objects and knowledge.

In a perspective proposed by Rowell (2004), knowledge gained through technology activities is that of technology as social practice and is mediated by the use of tools, resources and language within the community. This happens in the classroom as participants articulate strategies for achieving solutions to problems and assess their artefacts. The classroom practices reflect the collaborative endeavour in real life among designers, makers and users.

Collaborative activities have several cognitive advantages (Rogoff, 1998). In the Piagetian view, individual cognitive development is facilitated by cooperation between peers in resolving cognitive conflicts provided by their differing perspectives. In the Vygotskian perspective, cognition is an aspect of human socio-cultural activity. Mutual understanding in communication is a process that occurs between people, and cannot be attributed to one person or the other in communication. In such a view, cognition is manifest as changes in participation across different activities.

D&T and the challenges of equity and diversity

Catering to about 200 million school going children nation-wide, and hoping to enrol yet another 35 million who are out of school, the country's education system is torn by several conflicting interests (The PROBE Team, 1999). The national attempt to "produce a uniform level of achievement throughout the country" by providing "the same content delivered in the same way" ignores the cultural and regional diversity among Indian students and teachers. Theneed to promote a plurality of strategies to address the diversity of socio-cultural environmentshas never been more urgent or important. There are problems of mismatch between culture, educational content and pedagogy (Chunawala et al, 1996; Natarajan et al, 1996). But there is hope for change. Recent National Curriculum Framework documents, and the syllabi and textbooks based on them have attempted to address local contexts.

National Curriculum Framework (NCERT, 2000) document explicitly recognizes science and technology as organically linked and linked to society. Technology is essentially a human activity based on "our" constant desire to improve "our" condition. It is an organized way of creating "purposeful" change. What is not so clear from the documents is whose desires, conditions and purposes are served by either technology or technology education. What is worth teaching is as important as how that is to be taught. There is the challenge, of course, of ensuring conceptualization for diverse socio-economic and bio-geographical settings, while maintaining uniform standards that address content and process as well as cognitive development through at least as many educational boards as there are States in the nation.

Most rural areas have continuing traditions of indigenous and local technological practices despite facing severe odds. There exist wide cultural and resource differences among regions of the country including the rural-urban divide. Education has been perceived to contribute to the alienation of students from rural contexts of work and livelihood. Over 30% of the country's population is expected to be urban in another decade. Most urban classrooms, especially in English medium schools, are multi-lingual, with students coming from as many as a dozen linguistic backgrounds. Making education, especially technology education, inclusive assumes significance in the complex sociocultural context of India, where there is immense innovation potential across the country among the schooled and the unschooled, the formal and non-formal sectors.

D&T Education for a creative work force

The large number of students leaving the educational system by Class VIII implies that a productive and creative work force is possible only by addressing the educational preparation for innovation and creativity at as young an age as possible, preferably from the primary years. Whatever the form, it would be equitable to introduce such a component for all students across the country. What does school education provide in terms of employable skills such as knowledge and process, procedure, and team work skills? In school contexts across the country, where the emphasis is on studying theoretical principles and observing experiments conducted primarily by the teacher, students do not view science as a collaborative activity (Chunawala & Ladage, 1998). Even work experience, or any of its school-based variations, involves making socially usefulobjects using given recipes. It has little scope for design or examining contexts of use.

The education system does not encourage collaboration and constrains modes of expression. This can be alienating to a majority of learners (The PROBE Team, 1999). There is a need, and a rather urgent one, for a distinct model of education for innovation that integrates multiple modes of expression and values teamwork. The model must enable equitable participation of students from diverse backgrounds – rural and urban, of all gender orientations, coming from different socio-economic and linguistic backgrounds, and widely differing levels of exposure to technology and the designed world.

Designing vocational education

The NPE recommends vocationalisation of secondary education. Yet vocational and polytechnic courses at postsecondary level garner a total enrolment of only 1.5% of the total students passing out of secondary school. Of these 50% drop out and a large fraction are "unemployed". This is a paradox in the face of supply falling short of skilled labour demand. The major problems among several, include a low social status for such courses that largely attract academically backward and/ or economically weaker sections, inappropriate curricula, and absence of effective training for the work place in either knowledge, skills or teamwork.

The National Knowledge Commission (NKC), constituted by the Government of India in 2005 to study various aspects of education, at different levels, has recommended more flexibility in vocational education and training (VET). It also pointed to the need for quantifying and monitoring the impact of vocational education, and suggested re-branding to increase its perceived value and ability to command higher incomes (NKC, 2007). This implies teaching elements of design and critical thinking about technology and society not only to those in the vocational education stream, but also to all students in the generic vocational courses. What kind of technology education, if any, will be appropriate for a population

of 200 million in the school-going ages between 5 and 18 years, a very large number of whom have either never
enrolled in schools or have dropped out at various stages of education? In India, over half of those who enrol in Class I drop out by Class VIII, and more than two thirds drop out by Class X. Only 20% of those who enrol at Class I reach Class XII, and a mere 7% go for higher education (NFG-W&E, 2007; NKC, 2007). Those who drop out of the education system join – or aspire for – the world of work, most without acquiring employable skills. The nation is still far from adequately training for existing technology roles at the workplace. These are just some of the several compelling reasons to redefine the nature and place of technology in general education.

Towards a model of D&T education for India

The questions discussed so far indicate the need for a technology education with equitable access that can generate a creative and productive work force in the face of complex diversities. The technology education suitable for India will recognize the importance of context for learning and application, and will include design. But several issues of educational significance are still to be addressed. Should technology be clubbed with science? Science and technology share knowledge base and pedagogy. However, the implications of technology education extend beyond knowing science and scientific occupations, to vocational education and even social studies, art, ethics and value education. Clubbing technology with science drains the time available for learning science, which at present is adequate. Besides, the learning objectives of technology are not met. For one, the method of technology as distinct from the method of science is not recognised. It does not address the innovation potential of "doing". Some alternative curricula in countries (other than India) across the world have made serious attempts to redress this by integrating "design" and "make-it-work" activities in their curricular materials in science and other subjects (Ramadas, 1998, 2001).

In a recent article Ken Baynes (2006) opines that there are two apparently contradictory views of design and designing. In one view, designing and understanding design is a highly specialist, complex and esoteric thing, which people can only do after a long apprenticeship. Another holds that design ability - the ability to design and to understand design - is, like language ability, something that everyone possesses at least to some degree. He further suggests that on the basis of our understanding in cognitive science, the two views are complementary: the complex skills of design professionals are the result of development of abilities that all people possess.

The Design and Technology Education Project initiated at the Homi Bhabha Centre for Science Education (HBCSE) in 2000 explicitly holds the second broader view. A model for transaction of D&T activities in the classroom has been developed (Figure 1), as a step towards a possible school level D&T education curriculum (Choksi et al, 2006). This "collaboration and communication centred D&T education" model is inspired by the UK curricular model - the Design-Make-Appraise of APU. The approach of the project shifts the emphasis from the dominant global view of technology education emphasising use of digital technologies, and the local view of technology as merely applied science, to a collaborative engagement of student teams in designing, making and evaluation of need-based artefacts and systems.

Three D&T education units were developed through classroom trials: bag-making, windmill model making, and puppet making and putting up a puppet show. The trials involved students in Class 6 and 7 (age 11 to 13 years) from three school settings: English medium urban school, Marathi medium urban school and Marathi medium tribal school (*Ashramshaala*). Each unit, conducted over 15 hours was set first as a problem in the students' context. Investigation, the beginning of the sequence of tasks, provided opportunities for students to talk and write about related artefacts, explore available ones in their homes and in shops, and discuss their structures and functions. Students then explored their own ideas through group discussion and design sketches, used quantitative reasoning skills to depict their design of the artefact and indicated its dimensions. They made measurement and anticipated the making sequences, including work
distribution among members of their group.

While they were encouraged to discuss within groups, they also informally communicated with other groups and the researchers. Besides, communication was structured after the design stage and after they had evaluated their made products. Thus activities in each unit were designed to encourage communication and collaboration at various levels. Learning of relevant concepts was integrated with each unit through worksheets and suitable activities. Data was collected during the trials in the form of students' paper-pencil productions of drawings, structured and spontaneous writings, researchers' notes and audio and video recordings. The productions included design exploratory sketches, technical drawings, material lists and procedural maps, worksheets on concepts and evaluation, as well as the final product (Khunyakari et al, 2007; Mehrotra et al 2009; Khunyakari et al, 2007a).

D&T education research at HBCSE has been guided by an understanding that emerges from a study of philosophy of technology. It is also guided by theoretical perspectives on collaborative learning; cognition and action; concerns of sociocultural and gender appropriateness; and the development of language, quantitative, and problem solving skills. This approach to D&T education emphasises collaborative participation of students in design, making and evaluation of artefacts and systems (Kimbell et al, 1996). It is hoped that design, craft, and technology as part of general education (at the school level) will help attract a greater number and diversity (rural, girls, etc.) of students to careers in technology. The curriculum is designed to equip them with the trainable skills of perceiving and defining needs, and *designing* to satisfy them. The D&T activities will provide a context for students to select, learn and apply suitable techniques and skills and make judgments based on social, ethical and aesthetic values. A preliminary proposal of a curricular framework for a collaborative and communication-centred D&T education is given in Table 1.

At the pre-primary and primary levels (up to Class V), D&T education will aim to engage the child in exploring the world – natural environment, artefacts and people – and harmonizing with it. Exploring locally available materials through multiple senses and modes of expression besides being fun and engaging, will prepare primary students for the formal school subjects of science and social studies they will learn later. It will introduce them to skills of simple tool use and expose them to contexts that need those skills. The D&T tasks will involve the child in hands-on activities to acquire the basic cognitive and sensory-motor skills as well as in making explicit the tacit knowledge of technology.

Middle school students learn to contextualise and negotiate the design problem in groups, investigate potential ideas, plan for making the object, actualise their plan and evaluate the product. Working in groups, they discuss and communicate with other groups. They generate criteria to justify designs, make judgements about materials, joints, tools and techniques, and evaluate products. Thus they develop complex analytical and linguistic abilities. The simple technological units planned at this stage are aimed to give a broader view of technology, which manifests as objects, knowledge and activity. The activities integrate knowledge and skills across school subjects. Students at this level can engage in limited critical thinking exercises and are cognitively ready to appreciate simple links between science, technology and society, which can be introduced in the setting of goals, as well as during all communication sessions.

Students at the secondary and higher secondary levels (Class IX to XII) address simple real world problems for which they design solutions. The units are aimed to sensitise students to Study objective, learning goals of D&T education local environmental, health and other developmental concerns as they critically think through the connections between science, technology and society. The units involve working with more advanced tools and resources to design complex solutions. At this stage they interact with the local community and establishing the school-community linkages. Critical thinking in the area of science, technology and society is the thrust of the D&T education programme at the higher secondary stage. Before any school subject can achieve its educational aims, two major challenges have to be successfully met.

Assessment challenge

The first challenge is the assessment system that needs to be in conformity with both the philosophical background of the discipline on which the subject is based, as well as with the educational aims of the subject in developing students' capabilities. School education in the sciences has been struggling to meet these challenges for decades. Technology education shares at least some of the

difficulties. The assessment of written examination scripts by hundreds of thousands of students is itself a daunting task. Since 2004, there has been a move by the Central Board of Secondary Education (CBSE) to assess experimental skills of individual students in Class IX and X through their performance in a written test specially designed for the purpose. The experimental activity is beyond the existing assessment systems. As for including creative
drawings, models and the process of design and making, an entirely new way of thinking is needed. Perhaps, a more designerly way of thinking than what academicians and educationists
are accustomed to!

Teacher professional background challenge

The second challenge is the choice of suitably trained teachers with adequate and appropriate professional preparation. While this problem has been felt in several school subjects, including languages, for D&T education it is more complex. What designers know about their own problem-solving processes remains largely tacit knowledge. Hence design education relies on an apprenticeship system of learning. However, teachers of design need to be as articulate as they can about what it is they are trying to teach, or else they can have no basis for choosing the content and methods of their teaching. The difficulties arising from inadequate subject and pedagogic preparation, subject expertise and inappropriate attitudes among teachers are practical blocks to the implementation of D&T education for all.

While answering questions raised by teachers at the Wardha Education Conference in 1939, in relation to the introduction of handicraft based education for all, Gandhi elaborated that the teacher had to be both knowledgeable in the subjects as well as an expert in the conceptual and procedural knowledge and skills of the craft. This is a tall order.

Conclusions

The educational community seems to have a tendency to stay within familiar bounds. Creativityand critical thinking scare the educational system. Current systems cannot handle this easily. They are difficult to manage in classrooms, difficult to assess, and can even threaten existing socio-political systems. Parents and social systems are often uncomfortable with major changes in any aspect of education. Technology education poses an additional challenge by its sheer breadth of concerns. Technology as a notion is fluid and somewhat ambiguous. It is influenced by time and context – geographical, cultural, and socio-historical. Technological practices provide opportunities for creative design of artefacts to serve a socially and contextually appropriate negotiated goal. The design is founded on the integration of conceptual understanding of laws of the physical world, and the designer's experiences of dialogues with the world of materials. The materialisation of the artefact is through the use of procedures and hands-on skills and involves further dialogues with materials during the acts of making. Technology includes the evaluation of the artefact made in terms of the goals to be served and the consequences of its use. This introduces myriad teaching possibilities that imbue the subject with potential for inclusivity and equity, creativity and critical thinking, ecology of thought and action. For its proponents, this is what makes design and technology empowering in the school context.

Engineering in school education, on the other hand, might find greater acceptability. For one, it can be compartmentalised into mechanical, civil, etc., and that is very comforting. More importantly, engineering is inextricably linked to science and mathematics, the disciplines of prestige and power. In countries like the USA, the link between engineering, science and mathematics has motivated its inclusion as a school subject. It may be noted that mathematics and science subjects along with spoken English best serve to differentiate and discriminate among Indian school students, layer them and eliminate most from education beyond school. There is already a need to improve access and equity in school education.

The current state of the nascent discipline of technology education is characterised by a lot of ferment. Technology education in one form or another exists in several nations in almost all the continents. Africa, Asia and South America, which are large land masses and home to over half the global human populations do not yet figure in global discussions on technology in general education. This may reflect a lack of concern for technology education in schools in these countries. At the same time, the nature of technology education in populous countries like India, as well as China, Indonesia and Brazil can have a significant impact on the global socio-political and industrial scene.

Are we to presume that these nations have failed to perceive any merit in having technology in general education, or at least in the forms that it has assumed in the industrial countries? Is the technology education being perceived as exclusive or differentiated? Whatever the case, it is a matter of concern that India is not yet participant to the dialogues that are shaping the nature of technology education in several nations of the world.

The crisis in science and science education in the country co-exists with an aspiration for doing science among school students. It may be useful to address the portrayal of domain exclusivity at all levels of education and take corrective steps that can make school education truly "general". The exclusivity and compartmentalisation is also perceived by all educational stakeholders in the "streaming" of education beyond the school into the Arts, Commerce and Science. The cross disciplinary nature of all meaningful knowledge must be reflected in the design of curricula from school through specialisation in different disciplines at the tertiary level and beyond. Working with one's hands must take on meanings that are closer to the creative, while all school subjects must make room for creativity and critical thinking. This will not just benefit the learning of science; it will make the end eavour of science a lot more meaningful to all students. Besides, it has the potential to generate a vibrant and accountable scientific community, which is inspired by a lay populace that engages critically with science and technology.

A. N. Whitehead (1953) suggests that "There are three main roads along which we can proceed with good hope of advancing towards the best balance of intellect and character: these are the way of literary culture, the way of scientific culture, the way of technical culture. No one of these methods can be exclusively followed without grave loss of intellectual activity and of character." (P 111)

An education which includes experiences of designing and making, which inevitably involves taking qualitative decisions about competing alternatives, will help all people – current pupils and future citizens – return a personally valid answer to the question, "How do I want to live?" These aims urgently call for inclusion of design and technology in Indian school curricula, and hopes that all its empowering possibilities will one day be realised. For India, the urgent need to introduce design and technology in the curriculum harks me to the following words of Tagore (1913) in the English translation of his most famous work, *Geetanjali*:

Where tireless striving stretches its arms towards perfection; Where the clear stream of reason has not lost its way into the dreary desert sand of dead habit; Where the mind is led forward by thee into ever-widening thought and action - Into that heaven of freedom, my Father, let my country awake.

188 AGARKAR, S.C. (Homi Bhabha Centre for Science Education Tata Institute of Fundamental Research, V.N.Purv Marg, Mankhurd, Mumbai 400088). PARADIGM SHIFT IN SCIENCE EDUCATION.

Introduction

Rapid globalization, long lasting impact of IT (Information Technology), knowledge driven economy and strong domestic demands for developments have challenged existing education system and fuelled the flame of reform in different parts of the world. The education system too responded to these demands positively and has made some changes. Nevertheless it is necessary to understand the paradigm shift thoroughly and bring about appropriate changes in school education.

Paradigm shift

It might be useful to look at the traditional paradigm and new paradigm under three heads: Curriculum aims, curriculum characteristics and pedagogy characteristics.

Curriculum Aims

In the traditional paradigm, the aim of the curriculum is to equip students with the necessary knowledge and skills to survive in a local community or meet the manpower needs of the society. The new curriculum aims, on the other hand, aim at developing students as leaders and citizens who will creatively contribute to the formation of a global village.

Curriculum Characteristics

In the traditional paradigm, the focus of subject curriculum design is on content and delivery of subject knowledge structure in certain specialization areas. The structure of curriculum is mainly based on the structure of subject knowledge. Therefore the curriculum structure is often linear, step by step and subject content dependent. In contrast the new paradigm focuses on the design of subject curriculum on developing students' ability for lifelong learning and development. Therefore, the design is based on characteristics maximising opportunities for students' globalized, localized and individualized learning.

Pedagogy Characteristics

The traditional subject teaching emphasizes subject knowledge and skills to students. The pedagogy is mainly to ensure student-learning as a socialising process. It also assumes that closed supervision is necessary during the process of learning. There are usually site specific sources of learning and teaching. Teaching is classroom-bounded and has a characteristic of fixed period. There are often limited opportunities for learning. Pedagogy is driven by the delivery of subject knowledge and external standards in examinations.

The new pedagogy of subject teaching differs from the traditional one in a variety of ways. It aims at ensuring students' learning as a self-actualising, discovering, experiencing and reflecting process. There are multiple sources for the learning like for example self-learning, multimedia material, web-based learning, community experiential programmes, etc. Student-learning is globally and locally networked through internet and e-communications. This facility provides a wide spectrum of learning experiences. Thus, there are boundless and unlimited opportunities for learning inside and outside institution. The main aim of education is facilitation of learning and thinking in the global context.

Challenges to Teacher Education

The paradigm shift in subject teaching as discussed above give rise to notable changes in the teacher education. Efforts need to be made to enhance teacher competence in the delivery of subject knowledge. At the same time they need to be made aware of the paradigm shift in subject education. It must be noted that knowledge and skills taught today would be outdated soon. The students are to be trained for life long learning and to be prepared to meet challenges in a fast changing society.

Taking into account the context of globalization, localisation and individualisation in education the relationships among curriculum development, subject-teaching and teacher-education must be highlighted. There are two critical elements that influence the capability of a teacher. First is the mastery of subject matter and the second is teacher professional training. Pre-service and in-service training courses attempt to provide pedagogical content knowledge to teachers. These courses need to be planned taking into account the paradigm shift in subject teaching.

Some Illustrative Examples

Five sample examples are cited below to illustrate how the shift in subject teaching has affected the implementation of new educational programmes.

Example 1: Technology Education in Australian Schools

Since the release of Australian curriculum statement and profile in 1994 there has been a gradual shift in the curriculum content of teacher education programme. There is now a focus on technology education. Implementations of one such technology education programme needed three modifications:

- To move students from a view of technology education as a technological artefact or advancement to one which considers technology more broadly?

- Teacher education programme need to appraise national priorities and needs.
- Student teachers need to experience a range of approaches to teaching technology education.

Example 2: Integration of IT into Teaching in Singapore

The Ministry of Education of Singapore embarked on integrating IT in school education. There were three main challenges in the implementation of the programme.

- Acquiring new instructional resources and technology.
- Equipping teachers with new teaching practices.
- Influencing the beliefs and assumptions of teachers.

What needs to be done?

- Teachers need to have intellectual engagement with the rationales and ideas.
- Teachers need opportunities to re-examine their beliefs and teaching practices.
- Teachers need greater and more varied opportunities to interact with colleagues.
- Teachers need to be a part of active, larger communities that can provide support and ideas.
- Teachers need opportunities to experience learning in ways consistent with reform initiatives.

Example 3: Adopting World Wide Web as Learning Resources in Hong Kong

A study was conducted to see the effectiveness of using IT in teacher education courses. It was found that the IT major pre-service student teachers were able to learn independently using web-based and paper-based resources. Two groups of participants were very similar in terms of their knowledge before and after using web-based and paper-based resources. The subjects were able to understand and organize their thoughts better using paper-based than web-based resources. It means the potential of web as a learning tool has yet to be fully utilized by the participants.

Example 4: IT Training for Science Teachers

Science teachers are most suited for IT training as Science educators and teachers have often been taking leading role in the application of IT in education. There is a growing trend of using data-logging systems together with various sensors in many science experiments. Computer stimulated experiments are much more common in science for demonstration and laboratory practices. Also, in general, science teachers are holding a relatively positive attitude towards new technology like IT and they are faster in mastering technological skills because of their science background.

In spite of the above positive aspects there are difficulties in implementing the IT based projects. The areas of difficulty are: 1. Lack of support from the school management which often lacks IT awareness, 2. Hardware and software problem, 3. Classroom management problem and 4. Physical restriction of classroom and laboratory environment.

Example 5: Open Educational Resources for School (OER4S)

Homi Bhbaha Centre for Science Education (HBBCSE) a national centre of the Tata Institute of Fundamental Research (TIFR) for science and mathematics education has recently undertaken a project for developing open educational resources for bringing about quality education in Indian schools. The project is funded by the Rajiv Gandhi Science and Technology Commission of the Government of Maharashtra and is implemented jointly by HBCSE, Maharashtra Knowledge Corporation Limited (MKCL) and Indian Consortium for Educational Transformation (I-CONSENT). This project aims at designing suitable material for all the stakeholders of education namely students, teachers and parents and making it available on the website of the MKCL free of cost.

Open source material has been developed by organising the workshops involving practising teachers, teacher educators, subject experts and voluntary workers. These units have been processed electronically,

checked for their correctness, suitability and relevance. After modification the each unit is tagged properly for uploading in different domains. MKCL has come out with a suitable package for uploading and utilization of these units based on Content Development and Integration Tool (CDIT). The field testing of the material is going on. Although many of us use technology in our day to day life use of ICT in school education has not become a common practice yet. Many of the school teachers are not familiar with using web based material for classroom interaction. Moreover internet facilities are not dependable at many places. Efforts are being made to overcome these difficulties. It is hoped that a web based enrichment material will be made available for the benefit of Indian school system soon.

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189 REDDY, K. BALAVEERA (10,4th A Cross, 2nd Block HRBR Layout Kalyanagar Bangalore560063). GROWTH OF SCIENCE AND TECHNICAL EDUCATION IN INDIAN.

The science and technical education, particularly technical education, among other factors, determines the development and socio – economic condition of a nation. Therefore, there is a greater need for high quality science and technical education to produce a high quality man power. Now a days it is a matter of concern to realize a fall in the number of youngsters seeking careers in science. The scientific future of our country for the development of technology depends on the young scientists. The Professional courses, especially information and technology and engineering programmes have been drawing young students away from basic sciences. However, another reason is that the placement opportunities are less in the country for the students of basic sciences. Today most cream of trained scientists are moving towards west. It is therefore urgent that government must take policy decisions to train young scientists based on the national requirements and also keeping the global opportunities in mind.

The origin of science, in India has its roots in Vedic literature of ancient times datin back to over 3000 years. Contributions to science and technology by our forefathers are outstanding and well acknowledged the world over.

Our ancient seers, who are the path finders of science and technology are:

a. **Bharadwaja:** (Mahabharata Period) - was the first technocrat in missile technology, then known as "agneya".

b. **Patanjali:** (200 B.C.) - was a great teacher in yoga and presented fundamental technologies in Yoga Sutras. The eight stages of yoga described are Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana and Samadhi. The last stage of Yoga (samadhi) is the most difficult one which enables one to attain "God Head". What Patanjali advocated several centuries ago is now receiving the attention it deserve.

c. **Kanada:** (600 B.C.) - presented the 'Vaisesika Sutra' which are a blend of science, Philosophy and Religion. Their essence is the atomic theory of matter. He gave the name 'Paramanu' (Atom), to be the indivisible entity of matter and also said that the properties of Paramanu also changes when heated.

Former Vice Chancellor, Visvesvaraya Technological University, Belgaum, Karnataka State

d. **Susruta :** (600 B.C.) - was the first surgeon to operate disfigured nose using the juice of a medicinal plant. Susruta is recognized today as the father of Plastic Surgery all over the world. In Six Century B.C. itself he has proved that India was far ahead of the rest of the world in medical knowledge. He was the first physician to advocate what is today known as the "Caesarian" operation. He was also an expert in removing urinary stones, locating and treating fractures and doing eye operations for cataracts. He was also an excellent teacher. He advised his pupils to use models for practice before surgery.

e. **Caraka :** (800 B. C.) - was the First Physician, who travelled from place to place on foot to cure the suffering masses. He presented in the 8th Century B.C., the concept of digestion, metabolism and immunity. Caraka also knew the fundamentals of genetics, and studied the anatomy of the human body and various organs. He gave 360 as the total number of bones including teeth, present in the body.

f. **Aryabhata :** (500 A. D.) - studied at the University of Nalanda, which was considered as a great centre of learning. He was the first to state that the earth is round and it rotates on its own axis creating day and night. He declared that the moon is dark and shines only because of sunlight. Aryabhata also a great Indian mathematician. He gave the value of "π" as 3.1416, claiming for the 1st time, that it was approximation. Aryabhata also dealt with other aspects of mathematics and Astronomical calculations, namely Geometry, Square root Cube root, Progression and Celestial sphere. It was in appreciation of his contribution to astronomy and Mathematics that India's 1st Satellite was named "Aryabhata".

g. **Varaha Mihira :** (500 A. D.) - was a royal Astrologer in the court of King Vikramaditya and also a great scientist. Varaha mihira studied Astrology and Astronomy. He declared that the earth was spherical. In the history of science he was the first to claim that some "Force" might be keeping bodies stuck to the round earth. The "Force" is now called "Gravity".

h. **Brahma Gupta :** (600 A. D.) - was a great mathematician. He was the first to frame the rules of operation for ZERO. He also gave solutions to indeterminate equations of the type $ax^2 + 1 = y^2$ and the founder of the branch of higher mathematics called "Numerical Analysis". He said about gravity "Bodies fall towards the Earth as it is the nature of the earth to attract bodies, just as it is in the nature of water to flow."

i. **Nagarjuna :** (900 A. D.) - was a Chemist. The book written by him "Rasaratnakara" deals with preparation of rasa (mercury) compounds and also extraction of metals such as Silver, Gold, Tin and Copper from their ores and their purification was also mentioned in the treatise. To dissolve Diamonds, Metals and Pearls, he suggested the use of vegetable acids, sour gruel and juices of fruits and plants. The treatise discussed at length transmutation of metals into gold.

j. **Bhaskara :** (1100 A. D.) - was a great Mathematician and Astrologer. He was the first Mathematician to declare confidently that any term divided by ZERO is infinity and the sum of any term and infinity is infinity. His concept of "Tatkalikagati", which means instantaneous motion, used by astronomers to determine the motion of the planet accurately brought credit to him.

The ancient Indian scientists have contributed greatly for the path finding and guiding Principles in Science and Technology: like Physical sciences (Physics, Cosmology, Mathematics, Chemistry), Earth sciences (Geology, Environment, Gemmology), Biological sciences (Agriculture, Water management, Forestry, Vrksayurveda, Pasu Laksana, Ayurveda), Industry and Technology (Metallurgy, Aeronautics, Trade and commerce, Architecture) etc.

Physical Sciences :

The inevitable criterion stated by ancient Indian scientists is that "any thing created has to die naturally. Creation is invariably followed by destruction of what was created earlier".

The origin of mathematics, in India has its roots in Vedic literature of ancient times. The contributions by our ancient scientists to mathematics are outstanding and well acknowledged the world over.

The concept of zero, the concept of place value system in numeration, the concept of "Pi" the techniques of algebra, square root and cube root, the solution to quadrilateral equations etc. were clearly explained thus contributing significantly for the growth of the logical mathematical foundation for science and technical education. Even the technique of calculation called algorithm, which is today widely used in designing software programmes for computers was also derived from ancient Indian mathematics. These concepts have been carried to the west and adopted throughout the globe.
Ancient scientists were far ahead in chemistry compared to Europeans of those times. They used to make items of daily use (textiles, dyeing, tanning, perfumery, glass, ceramics, gems, cements, mortars etc.) and even medicines for humans and animals from agricultural products and minerals etc. Several chemical processes for extracting metals like gold, silver, iron, copper, zinc etc. from their ores and making alloys of these metals were developed in ancient India.

The ancient Indian geologists studied various aspects "Bhoomisastra" (Geology) such as geochemistry, geophysics, and geochronology.

The ancient sanskrit literature gives invaluable gems of physical sciences. The seismological zones of Varahamihira bring out the value of such gems.

The seismological zones of Varahamihira when plotted on a map show a positive correlation with the modern stress zones. This not only explains the efficient scientific pursuits of the ancient Indians, but highlights superior scientific capabilities of ancient Indian scientists and even supplements modern seismology.

The ancient seers of India through their vision of global harmonious living as a family for the benefit of entire world had advocated that all activities should be Eco – friendly. The aim of the seers has been to create a blissful surroundings where human beings and animals could co-exist peacefully with nature.

The ancient Indians firmly believed that the Pancha Maha bhutas (The Earth, The Water, The Fire, Air and Space) bring immense benefits to the human beings in their day to day life. From the earth, they knew that they will get the most important food apart from many other natural sources like water and numerals.

The Vedic literature contains a good deal of information about agriculture. The Rigveda and Yajurveda bear ample testimony of harvesting and preserving the corn. Pests damaging corns and the means of saving these have been referred to at various places of the Atharva-veda.

The Vedic and Post-vedic Indian society and culture was greatly influenced by agriculture. The medical tradition in India goes back to Vedic times. The ancient Indian seers contribution in the field of medical sciences such as Ayurvedic treatment, Plastic Surgery, extraction of cataracts, dental surgery etc. has witnessed phenominal growth of science education. Ayurveda is an encyclopedia of the ancient medical knowledge. It is not only considered to be merely a compendium of therapeutics based on herbal, animal and mineral resources of the world but also a philosophy of life and living. About one-fifth of the human race even practiced Ayurvedic treatment today despite of its antiquity.
Ancient Indians had a very good knowledge of minerals and technology of production of quality metals. The great Iron Pillar near the Qutab Minor, at Mehrauli in Delhi presently called as "Rustless wonder" is a monumental and standing example of high quality steel. The iron pillar remains a mysterious wonder for the technologists even today for producing such a high quality corrosion resistance iron.

The ancient Indian literature mentions about the science of Architecture and also Palaces, Forts, Towns, Temples, bridges, buildings, market centres, art galleries, roads, ports and harbours, digging wells, tanks, dams and many more.

The development of science and technical education in India can be credited to the British although during that time the science education was rather limited.

The first technical school (survey school) was established on Indian soil on May 17, 1974, in a building near Fort St. George in Madras with eight students. The Madras Survey School was training only English boys in the beginning.

The first Engineering College was established at Rourkee on January 1,1848. With in a few years, engineering Colleges at Calcutta (November 1856), Madras (September 1857) and Poona (1864) followed.

The All – India council for Technical Education (AICTE) was constituted by the Govt. of India on November 30, 1945 as an advisory body.

Some of the most well known scientists who engaged in globally competitive research belong to this period. The great scientists like Sir C. V. Raman, J. C. Bose, S. K. Mitra, Birbal Sahni, S. Ramanujam, M. N. Saha, S. N. Bose, K. S. Krishnan, , P. C. Mahalanobis and P. C. Ray inspired an entire generation of students.

At the time India became independent, the total annual intake capacity in Engineering and Technology was 6240 which included 3670 at technician level, 2500 at undergraduate and 70 at post-graduate level, whereas on today, this total intake capacity in Engineering and Technology increased to more than one million.

At the time of independence, the country hardly had an industrial base and trained manpower for the task of nation building. The planners are more ambitious for allround development of the nation. Large investments were made in establishing national laboratories for scientific, industrial, agricultural, medical, atomic energy, space, ocean, defense etc. For the above aforementioned areas suitable manpower was needed at all levels. The major problem during that period was an acute shortage of trained technical manpower. These has resulted an enormous growth of technical education for the past six decades

After independence science and technology education especially technical education in India has witnessed phenominal growth with Pandit Jawaharlal Nehru's Vision. Nehru's vision was translated into working plans through government education polices over the years. The country produced the largest and one of the most diverge science and technical education infrastructure.

To impart science and Technical education and training there came up several national level institutions such as Indian Institutes of Technology (IITs), Indian Institutes of Management (IIMs), School of Planning and Architecture (SPA), Technical Teacher Training Institutes (TTTIs)Regional Engineering Colleges (RECs) and many Universities and Colleges. This infrastructure has successfully produced one of the largest scientific and technological manpower in the world.

After Independence, some of the well known scientist & technologists are Benjamin Peary Pal, M. S. Swaminathan, Sambu Nath De, Avtar Singh Paintal, P. C. Ray, D. N. Wadia, S. S. Bhatnagar, T. R. Seshadri, G. N. Ramachandran, Devendra Lal, C. N. R. Rao, A. P. J. Kalam, H. J. Bhabha, V. A. Sarabhai etc.

But today, while in the emerging global scenario it is being realized that the only way to improve the nation's competitiveness is through better science and technical education. The National Science Survey – 2004 has indicated that concerns about falling in science enrolment in the country especially at the higher levels. At the school level too there is ample scope for improvement in science education as far as new teaching methods, provision of state of the art laboratories with best scientific equipment and design of curriculum and preparation of resource materials.

CONCLUSION

The growth of science and technology in any country will be a key factor in determining its status and power in global scenario. Therefore in this competitive juncture of globalization, quality science and technical education is the need of the hour. But the higher education is now facing many challenges which also create ample opportunities and room for quality improvement. To achieve the Mission 2020, the country needs scientists and technocrats who will contribute to society through productive and satisfying careers as innovators, decision – makers and leaders in the global economy of the twenty first century. To achieve this, the higher education system in the country need to be strengthened which will be capable of honing the students to attain all – rounded ,multi – faced personality; to acquire leadership qualities and knowledge of the latest trends in science and technology, to sharpen communication and interpersonal skills, to have exposure to Research &

Development and industrial climate and to gain confidence to face challenges in the highly competitive world.

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190 SINHA, MUKUL (2,Swagat Palace Opposite Ambali Bus Stand Bhopal- Ambali Road, Ahmedabad 380058). CLASS NATURE OF SCEICNE AND ITS EDUCATION.

1) Is science circumscribed by class interest? Does the dissemination of science suffer from the same ailment?? Many of our leading scientists and intellectuals would be aghast even for posing such obnoxious questions. Surely, science and knowledge cannot have any boundaries and least of all, class boundaries!

   Ofcourse, to those of us who are born in this country, these two questions ought not to really cause any shock. Not very long ago, a few hundred years back also, our society had very definite rules for acquiring knowledge for different sections of the society. The Manusmriti, which was a codified law of the past, prescribed stiff punishment to shudras if they dared acquire the knowledge of Vedas. The clause XII.4. of the code stipulated the following:

   XII. 4. If the shudra intentionally listens for committing to memory the veda, then his ears should be filled with (molten) lead and lac; if he utters the veda, then his tongue should be cut off; if he has mastered the veda his body should be cut to pieces.

   The shudras, in the name of lord was ordered to serve others and not to learn. The clause I-91 of the code prescribed the duties:

   I – 91. One occupation only the lord prescribed to the shudra is to serve meekly the other three castes.

2) The frontiers of science move only as we resolve our contradiction with nature. This constant struggle between us and the nature pushes the knowledge content of the society; but this struggle takes place at different epoch at different levels of the development of the productive forces. But as we know, the development of the productive forces itself depends on the production relations at any stage of history. This production relations sometime become the engine for driving the productive forces to higher degrees whereas at times the same become fetters to its further development. This contradiction between the productive forces and the production relation relates directly to the classes participating in the process of production and thus gets related to the class-struggle. Thus, science and knowledge itself get related to the class contradictions. This obvious truth does not however become evident if we look at scientific knowledge in its abstraction. But the moment we scrutinize the manner of research, dissemination and application, the class nature of science become very obvious.
3) As students however we are made to believe the otherwise. Science is raised to a high pedestal and the scientists assuming the role of selfless saints. How true are these images and profiles that are created??
4) India under Jawaharlal Nehru, did adopt a very secular and scientific attitude towards the education and cultural development of post independent India. Though the lower levels of educations were not paid sufficient attention, Higher Institutions of Science and Technology did come up under the earlier plan periods. Major Universities developed across the country. Cost of

education was also relatively low and elitism was yet to creep in a big way. But all that changed with the wind of Globalization blowing away the fig leaf of socialist pretensions.

5) But much before the virus of privatization could attack the vitals of the education system, the bureaucratization of the public Institutions run by the Government had already become a major fetter for the advancement of science and education in India. The authors own experience in this regard can help understand the malaise.

6) After completing MSc in physics from IIT Kanpur in 1972, the author had joined the Physical Research Laboratory for his PhD in Plasma Physics. After the completion of PhD in 1977, the author had joined as a Visiting scientist in PRL itself. In 1979, a protest against a supervisor for kicking a class-IV employee led to a lock-out in August 1979. Since the author refused to give in to the unacceptable demand of the PRL Management to sign an undertaking declaring allegiance to the Management, he was promptly dubbed as the trade union leader and his services came to be ended by December, 1979.

7) This authoritarianism born out of the bureaucratization of the public Institutions all over the country led to several trade union movements all across the country and instead of co-operation which should be hall mark for the quest in science, the staff and the Management work at cross purpose.

8) The enormous amount of money invested by the Government in the public Institutions and the Government's deep and pervasive control obviously led to politicization of the scientific Managers and the recent disclosure of the Pokhran-II dud reveals the extent to which scientists could lie to appease their political bosses. The sudden termination of the Chandrayan project would also raise similar questions since as reported, it appears that the DOS scientist forgot to take into account the heat effect from the moon's surface on the Chandrayan leading to the failure of its controls. Was it because the political bosses hurried up the entire launching resulting in this blunder?

9) The next major hurdle for the Indian education system from the class point of view is the massive privatization and commercialization of the entire system. Privatization of every type and level of Institutions and introduction of capitation fee and high levels of term fees have now made good education out of reach of the poor and the middle class. In the name of merit, Manusmriti is back in a new form. Dalits are virtually deprived of any higher education. Self- reliance has given away to buying technology of the shelf. Research or whatever we did, has given away to training our multitude to make them fit for the employment market.

10) With the integration of India with the capitalist network in this era of Globalization, the class nature of science as well as the education system is now becoming abundantly clear. Profit being the primary motive force driving the production, all funding also get channelized only towards such research that can lead to a development of profitable products. The entire defense-military establishment of the western world funded the nuclear and space research precisely because that yielded to hugely profitable weapons for mass destructions.

11) If we examine the division of labor across the globe it can easily seen that the Asian and Chinese part of the sub-continent have become the manufacturing backyard for the advanced countries. The high end of the science and technology will ofcourse be the prerogative of the advanced western block and the cheap labor of the Chinese-Indian sub-continent with imported technology will be the manufacturing centers for the supply of the consumables and that too at an unfair rate of exchange!

12) The primary goal of peoples' science should be therefore to unshackle science and research from the narrow bounds of class interest and direct the research into the needs of the people rather than the profit of any business. Both from fundamental science as well as material point of view, we need to keep the people's need at the centre of our concern and allow a wide participation of the people themselves in this process. The existing status-quo in the progress of science and technology can be altered only if we can free science from the shackles of profit motive.

MEDICAL AND HEALTH SCIENCE EDUCATION IN INDIA

191 BANERJI, DEBABAR(B-43 Panchseel Enclave New Delhi 110017). EDUCATION OF WESTERN MEDICINCE IN INDIA.

Study of education of Western medicine is particularly inadequate in a country like India. It is not adequately realized that *Western* medicine has its roots in the *Western* countries. It is also a part of the European Enlightenment of over the 5-6 centuries and therefore it is scientific in character. It was implanted into India where the soil is very different culturally, socially, economically and epidemiologically; Western medicine was implanted when there were already many forms of pre-existing medical practices. This implantation has also been associated with colonial conquest and imperial exploitation. Sustained growth of the knowledge of Western medicine has increasingly led to commoditisation of its practice. Because of the class character of the population of the country, opportunities for getting access to medical education was limited to a very tiny fraction, whose children knew English. All such fundamental considerations ought to have been taken into account in a study of shaping of medical education, research and practice in this country. Evidently, this will need a wide range of interdisciplinary work. Apart from the complexity of interdisciplinary dimensions of medical education, the study will need their blending with other disciplines like medical anthropology/health social sciences, history, health economics, political economy and public administration. This blending leads to formation of what can be termed an `interdisciplinary language' which is used in the course of this presentation.

Pre-existing Systems of Medicine

It is not necessary here to give even a gist of India's more than five thousand years' history of its indigenously developed mechanisms. They will be mentioned only in so far as they elaborate on the process of introduction of Western medical education and practice the country. The ancient science of Ayurveda had visualized health as the maintenance of balance and harmony between environment, body, mind, and soul. Health was conceived to be a permanent contest for preserving such a balance and wholeness and, ultimately, is its reflection in a high level of consciousness (1). Yoga formed a part of Ayurveda. It focused on aspects of methods of health promotion and prevention and treatment procedures for certain illnesses. Later discoveries of viruses and bacteria are incorporated in Ayuerveda as a small component of `environment'.

Expectedly, contents of the science of Ayurveda had undergone frequent changes with the various kinds of changes that have taken place in the country over the long period. These include changes in the epidemiological situation, changes in human ecology, demographic changes, changes in the political geography and changes in power relations. Health problems and health practices and cultural meanings and perception of health and diseases have also changed in the course of the long history.

D P Chattopadhyay (2) had pointed out that by the second century BC, Ayurvedic medicine had already taken the momentous step of becoming rational therapeutics. Physicians created a methodology based on supreme importance of direct observation of natural phenomenon and the technique of rational processing of empirical data. According to them, therapeutic power of physicians laid in their understanding of the laws inherent in nature which governed both human beings and nature, emphasizing their identity. The pharmacology which Ayuervedic medicine developed is colossal and is significant for giving direction even to current pharmacological research. Samhitas written by scholars like Charaka and Susarta were used for education of Ayurvedic physicians and surgeons.

Till the European Enlightenment, the quality of practice of medicine in the Western countries that was far behind what was described by Chattopadhayay for Ayurveda in India. However, the Enlightenment ushered in the era of scientific thinking based on experimentation, observation and drawing of inferences. It created a chain reaction, leading to cumulative developments in the fields of medical science. The current

Western medicine is distinguished from Ayurveda in the sense that it is based on the scientific processes that are rooted in the Enlightenmrnt.

Developments in science and technology was associated with rapid expansion of trade and commerce, which led to imperialistic plunder, colonial conquests of many non-Western countries and occupation of mainly uninhabited lands in different parts of the world. When the British East India Company (EIC) started its venture of colonial conquest of this vast country, the people of the country continued to show lack of interest in Western medicine even though considerable knowledge had continued to accumulate during that period. Despite all the decay and degeneration, the people continued to prefer using their own practice of the indigenous systems of medicine and home remedies and other healing practices to cope with their health problems. Indeed, as had been pointed out by A L Basham (3), as late as in the early nineteenth century, surgeons from the East India Company learnt aspects of plastic surgery from Ayurvedic surgeons of India.

Induction of Western Medicine

Like any other armed force, that of the EIC also had its medical unit to attend to the health problems of its military personnel. This unit was manned by personnel belonging to Indian Medical Service (IMS). The IMS was given a civilian wing to provide medical services to employees of the EIC and to Europeans who traded with the country. The exponential growth in the extent and the range of activities of EIC, which culminated in its becoming the supreme ruler of most of the country by the beginning of the nineteenth century, had led to a corresponding increase in the expansion of the activities of the IMS. With the passage of time, a very thin upper crust of the `native' population, which collaborated with the colonial rulers, also obtained some access to the services provided by the IMS. A distinguishing feature of the cadre of the IMS was that it adopted a holistic approach the health problems of the people it served. It included all aspects of curative, preventive and promotive needs of the people, embracing education, training, research and practice aspects.

Establishment of the three medical colleges by IMS personnel at Calcutta, Bombay and Madras around 1835 was an important landmark in the history of the health services in the country. These medical colleges followed the guidelines laid down by the General Medical Council of Great Britain. This imparted a degree of rigour to the education given to the students. Another ten medical colleges (and a number of medical schools to offer three-year `Licentiate' courses) were started before the British rule ended in 1947. Interestingly, the nursing profession in India was established at quite an early stage. Florence Nightingale herself took a special interest in developing the profession in the country.

It was quite natural that IMS officers should nurture the medical colleges during their infancy. However, along with the `scientific core' of the medical sciences – a most welcome diffusion of the cultural innovation from the Western world – there came certain political, social and cultural `overcoatings'(as very appropriately termed by Hugh Leavell) that were inimical to the interests of the bulk of the country's population. English was the medium of instruction that was understood by a miniscule section of the population. Even today less than five per cent of the population know enough of the language to avail of facilities of medical education. This trend of excluding more than 95 per cent of the population till today forms by far the most malignant feature of medical education in particular and higher education in general. It is also almost comical that the authors of the recent report of the `Knowledge Commission' and the Yashpal Committee, both dominated by Brown Americans, should have been so `unknowledgable' about this elementary fact and the government is busy formulating its policy on the basis of such a colossal ignorance.

Furthermore, the statutory body of the Medical Council of India (MCI) was formed to follow the British norms in order to gain recognition of the Indian degrees from the British Medical Council. This enabled some Indian physicians, who were the select among the select, to go to Great Britain for higher medical education to get more thorough indoctrination in the course of getting fellowships or memberships of various Royal Colleges. On return, they acquired dominant leadership positions in almost all facets of

the medical profession of India. They conformed to Macaulay's vision of a Brown Englishmen. Because of the class and language advantage of this group, the country still suffers from domination by a mix of a miniscule fraction of `Brown Englishmen and Americans' population of the country.

The British rulers were themselves deeply concerned about the limitations of the then existing health services that were made available to its own people. The mortality and morbidity rates among them was unacceptably high. Probably unwittingly following the dicta of multiple causation of diseases that was being preached by Rudolf Virchow (4) of Germany around that time, the British set up exclusive cantonments for their army and civil lines for their administrators to protect these vital organs of the state from the depredations of various kinds of diseases which were extensively prevalent at that time. They had pointedly barred the `natives', including native soldiers, from these exclusive zones. Learning from the sanitary movement of England, they also adopted sanitary practices of supplying protected water, proper disposal of wastes of different kinds and maintaining general cleanliness in these exclusive zones. This marked the beginning of widening of the gulf in the access to health services between the rulers and the vast masses of the country.

That also happens to be the period when the spectacular developments had started taking place in the practice of medical sciences in the West, leading to discoveries of vaccines, sera and chemotherapeutic drugs against some of the scourges. It was given an even greater push by the major breakthroughs in medical and public health research during the two World Wars. As the scientific approach adopted in the growth and development of Western medicine was a cumulative process, it was acquiring an increasingly powerful momentum, which took an almost exponential form in the subsequent decades.

These provided a potent motive force for development of the health services to give protection of the ruling class against the diseases and leave the vast masses of the people to the depredations caused by various scourges. This differential access to medical/health services thus became an important weapon of suppression of the oppressed masses. The outbreak of a massive epidemic of plague around the beginning of the twentieth century reinforced this trend. The setting up of the Malaria Institute of India at Delhi, the Haffkine Instiute at Bombay, the Medical Research Laboratories at Kasauli and the King Institute of Preventive Medicine at Madras have been the outcome of this movement. Indeed, after Robert Koch's path breaking work, the Government of India had deputed two IMS officers to Koch's laboratory to get trained under his guidance. The Calcutta School of Tropical Medicine came into being in 1926. The All-India Institute of Hygiene and Public Health was set up at Calcutta under the leadership of John Grant in 1938. Each one of these institutes had acquired considerable reputation at that time in different parts of the world, particularly in the `tropical' countries.

At the same time, as a result of the colonial policy of shifting state patronage from pre-existing indigenous systems of medicine (ISM) to the Western system, these already stagnant systems were caught in a vicious cycle. The very neglect accentuated their decline, and the decline, in turn, made it increasingly difficult for these systems to compete with the highly favoured and rapidly flourishing Western system for the support of the newly emerging Indian elite educated in the Western style. Concurrently, colonial exploitation also created adverse environmental conditions, which further accentuated the already serious health problems of the masses. There were frequent outbreaks of famines and epidemics, extensive prevalence of communicable diseases and chronic hunger. The colonial exploitation of the masses in the form of more ruthless extraction of revenues added substantially to their already miserable conditions. This made them much more vulnerable to diseases of various kinds and to famines and epidemics.

Thus, at a time when spectacular developments were taking place in different branches of the Western system of medicine, which continues to this day, the indigenous systems of medicine came to be dominated by persons with very limited competence. This almost totally eroded the very limited scientific or empirical content that still existed in these systems.

By the time the British left India, official figures (5) have shown that in terms of mortality and morbidity, the country ranked low among the nations. Expectation of life at birth was 26.9 for males and

26.5 for females. Nearly half of the total number of deaths was among children under the age of ten and, in this age-group, half of the mortality took place within the first year of life.

The state of health of the people of the country invoked sharp response from the leaders of the freedom movement. An important feature of health policies, plans and programmes in India is that they originated during the national movement. The struggle for improving health status of the people became a part of the anti-colonial struggle. B C Roy, a prominent physician member of the freedom movement, who was also the President of the Medical Council of India and the Indian Medical Association (6), made important contribution to this line of thinking. An instance of this assertion is found in the speech he delivered at the National Medical Conference, held at Lahore in 1929.

Portions of B. C. Roy's Presidential Address are quoted below as they present many important facets of activities in the field of health during the national movement. Starting with the question of involving practitioners of indigenous systems of medicine (*vaids* and *hakims*) in the then recently established Indian Medical Association, he observed: `Should we restrict the membership to such persons only as follow the Western system of Medicine? ... If we take medicine merely as a science it may be argued that only those who are trained on scientific methods prevalent in the West should be eligible to be members. But to my mind it is taking a very narrow view of the whole matter. On the other hand, if we define science as a systematised branch of human knowledge we cannot ignore other systems ...it is not for us to cut off from the past systems but it is necessary to resuscitate them and to develop them. If we desire to do so, we cannot afford to keep out the *Vaid* and the *Hakim*. We cannot ignore them... if we regard medicine as an art of healing, who is there so bold as to say that the art is the exclusive achievement of one system?'

Taking note of the strong colonial influence in the making of a physician in India, B. C.Roy called for efforts to promote self-reliance and self-confidence and to make medical education relevant to Indian conditions: `We know we have been wronged in the past. We do not desire to depend on others. We, therefore, desire to utilize such powers as the Universities and the Councils of Medical Registration in different Provinces have given us for the purpose of developing medical education in our own way'.

A National Health (Sokhey) Sub-committee of the National Planning Committee (NPC) of the Indian National Congress was set up in 1938 (7) to make recommendations to improve the situation. The recommendations and resolutions of the Sokhey Committee (1940) are of significance in tracing the roots of future policy in the field of health. The remarkable foresight of the Sub-committee is reflected in the very contemporary tenor of the resolution adopted by the NPC on August 31, 1940, on the basis of this report. The integration of curative and preventive functions in a single state agency was urged and it was stressed that the maintenance of the health of the people was the responsibility of the state. To meet the immediate situation, the need for training large numbers of health workers in practical community and personal hygiene, and implications of medical and public health work, was emphasized. The provision of one health worker for every thousand of population was aimed at within five years. Practitioners of the Ayurveda and Unani systems were to be drawn into the state health system, after giving further scientific training when necessary. Other aspects covered were nutrition, expansion of medical education and research, compilation of an Indian Pharmacopoeia, and production of drugs.

Thus, even as early as 1940, India's leaders had already envisaged a people-oriented health service, Significantly, the Final Report (1948) of the National Planning Committee categorically stated that `the cornerstone of the scheme we recommend is a (Community) Health Worker'.

The NPC also endorsed the findings and recommendations of the Health Survey and Development (Bhore) Committee (5), which had submitted its report in 1946. It described them as being `of the utmost significance', because it felt that this committee was a fully representative body consisting of nine officials, including the Minister of Health, the Director-General of Indian Medical Service, some Surgeons-General from leading Provinces and 11 non-officials, including private practitioners of international fame and members of the Central Legislature. The Bhore Committee Report is to this day regarded as an authoritative document, not only because of its distinguished authorship but also because many of its proposals and recommendations continue to be pertinent and valid even today. The report was submitted to

government in 1946. The several minutes of dissent based on cogent arguments on one or more of the issues discussed indicated the depth of individual involvement as well as the depth of agreement on points where there was no dissent. A significant dissent pertained to the abolition of the three year Licentiate course. It was accepted by the majority on the ground that there should be no `classes' of health services to the people. Later, in 1963 the Health Planning and Development (Mudaliar) Committee (8) also concurred with the idea of abolition of the Licentiate course.

The guiding principles adopted by the Bhore Committee were:

No individual should be denied adequate medical care because of inability of pay for it.
2. The health services should provide, when fully developed, all the consultant, laboratory and institutional facilities necessary for proper diagnosis and treatment.
3. The health programmes must, from the beginning, laid special emphasis on preventive work.
4. Medical relief and preventive health care must be urgently provided as soon as possible to the vast rural population of the country.
5. The health services should be located as close to the people as possible to ensure the maximum benefit to the communities served.
6. The active cooperation of the people must be secured in the development of the health programme. The idea must be inculcated that, ultimately, the health of the individual is his own responsibility.
7. Health development must be entrusted to ministers of health who enjoy the confidence of the people and are able to secure their cooperation.

The Bhore Committee also emphasized the need for social orientation of medical practice and a high level of public participation. According to it, the physician of tomorrow must be `a scientist and social worker, ready to cooperate in teamwork, in close touch with the people he disinterestedly serves, a friend and leader he directs all his efforts towards the prevention of disease and becomes a therapist where prevention has broken down, the social physician protecting the people and guiding them to a healthier and happier life. ...'.

TheBhore Committee visualized that `a health organization enriched by the spirit of such a medical profession will naturally work towards the promotion of the closest cooperation of the people. It will recognize that an informed public opinion is the only foundation on which the superstructure of national health can safely be built'.

Based on the many insightful propositions to improve the very dismal state of health of the poor, leaders of the freedom movement had dreamt of the health actions they would undertake after India gained independence. These, however, remained mere dreams in the changed political conditions of post-independence period. As pointed out by Gunnar Myrdal (9), when the native ruling elite took over power from the British, to pretend to meet the limited democratic aspirations among the masses of the people, they made lofty egalitarian pronouncements but depended essentially on the colonial machinery bequeathed to them by the British to ensure that the fruits of independence would fall into their laps. Anti-colonial struggle took the form of a power struggle between the well-off ruling classes and the huge poverty stricken masses. B. C. Roy, for instance, who became the Chief Minister and the Health Minister of West Bengal during 1948-62, could do very little in line with the exhortations he had made at the Lahore Conference in 1929.

In contrast to the rural health services, the urban health system continued to receive much greater attention. Public funds were made available to establish a number of hospitals in urban areas, many of which had the latest, sophisticated equipment for providing intensive care, open heart surgery, brain surgery and cancer therapy services on the model of the industrialized countries. The Western industrialized countries also provided a reference frame for institutions for education, training, and research. Personnel from these sophisticated, urban-based institutions have remained heavily dependent on their counterparts in the industrialized countries and the latter have actively encouraged such dependence by providing `technical assistance' in the form of training, consultation and `cheap' textbooks. This link up of the rich well off class of Indians (Brown Englishmen/Americans) with their counterparts in the rich Western countries has played a major part in creating the dominant position for Western medicine and a virtual disappearance of the indigenous systems from the country today.

It may be pointed out that the political situation had dramatically changed because of changes in the power structure in the country after Independence. However, during the early years, the new rulers were impelled to carry over some of the democratic processes that were articulated during the freedom movement in making decisions concerning health of the masses. Taken as a whole, these decisions gave a perspective to public health principles and practices in the country which was markedly different from the ones preached in the conventional schools of public health in Western countries or elsewhere. Despite considerable difficulties and shortcomings, India could develop an endogenously developed, alternative body of knowledge that was more suited to the social, cultural, economic and epidemiological conditions prevailing in the country. This led to the emergence of an alternative approach to education, practice and research in public health in the country.

Following the acceptance of the report of the Bhore Committee by rulers of the newly independent country, a start was made in 1952 to set up Primary Health Centres (PHC) (10) to provide integrated promotive, preventive, curative and rehabilitative services to entire rural populations, as an integral component of a wider Community Development Programme (11) – it sought to be an integrated health services as a component of inter-sectoral action, as was envisaged much later in the Alma Ata Declaration on Primary Health Care (12).

The knowledge gained in setting up PHCs all over the country was meant to lay the foundations for social orientation of medical education in the country. Early in the 1950s, the previous very indifferent teaching of hygiene and public health was replaced by full fledged departments of preventive and social medicine on the lines recommended by the Bhore Committee (13). This posed a major intellectual challenge to produce academics (a) who are well conversant with the conventional teaching of hygiene and public health; (b) who can expand the discipline to bring it in tune with the existing social, economic and political setting of the country; and (c) who could impart social dimensions to the teaching of the clinical sciences to students, as envisaged by scholars like John Ryle and Rudolf Virchow.

A number of evaluation/review committees indicated concerns about failure to fulfill these ventures. A high level Group (Srivastava) on Medical Education and Support Manpower constituted in 1973 (14) underlined the very sorry state of medical education in the country and recommended `a radical programme of reform in medical and health education'. It advocated `immediate, vigorous and sustained implementation' in tackling important issues. Even this passionate effort failed to arrest the sustained downward slide of the quality of medical education in the country.

This failure called into question the majority recommendation of the Bhore Committee and that of the Mudaliar Committee on abolition of the three year Licentiate course. Apparently, because of presence of stalwarts like John Grant and Henry Siegerist of the Johns Hopkins School of Medicine of USA in the Bhore Committee, one of its recommendations was to establish an institution on the same model in India – the All Institute of Medical Sciences (AIIMS). This idea was immediately accepted by the national government of India. Two of the important mandates given in the Act Parliament for AIIMS were: (a) to set up a department of social and preventive medicine to serve as a model for the other medical colleges in India; and set up a department for the study of medical education to stop the slide of the quality as described by the Srivastava Committee. AIIMS failed on both counts, because it failed to attract creative scholars to undertake these challenging assignments.

The notion of integrated manpower development was virtually unknown at that time. The prevailing physician-nurse ratio, for instance, was atrocious. It was confined to the interests of the rich political class. The politicians vied with one other to have medical colleges established in major cities. This was the first indication of the Medical Council of India (MCI), which has been given statutory responsibility of maintaining the standard of medical education, giving in to political pressure. The number of medical colleges shot up from a mere 13 in 1947 to 105 in 1971. The motive was to have a well equipped government funded hospital in the city (apparently mostly for the benefit of the privileged classes) and have opportunities for their English knowing children opportunities to qualify in medicine. It so happened that at that time there was a severe shortage of medical personnel in the UK due to the World War II losses and the manpower needs of the newly started National Health Service (NHS). This led to great influx of the expensively trained personnel from a poor country like India to serve in the NHS.

The damage was already done. Mediocrity became a norm in the faculties in most of the medical colleges. Leaving aside brain drain and retirements, the 13 medical colleges of 1947 had to supply teaching staff to 105 medical colleges within 25 years! The British Medical Council and many other recognizing bodies withdrew their recognition of Indian degrees. While the number was frozen to 106 till 1983, there was sustained pressure for creating facilities for admission to medical colleges. A very significant outcome of exertion of this pressure was that enormous sums of money was paid to politically influential persons to open privately funded medical colleges – the so-called `capitation fee colleges'. Politicians from the states of Karnataka, Andhra Pradesh and Maharastra were at the forefront in setting up patently sub-standard `medical education shops'. Thus, the English knowing children of the miniscule privileged classes, who could not get admission in competition in government funded colleges despite all the advantages they enjoyed, used their wealth to get admitted to these private `medical education shops'. It was a most blatant form of commoditization medical education. This bred extensive corruption in getting a degree from the university and getting these sub-standard degrees recognized by the MCI. Not surprisingly, soon the MCI itself got enmeshed in corrupt activities. At the last count, MCI had extended its recognition to as many as 298 medical colleges. In addition, it has extended its `permission' to carry on teaching work for varying periods to many more medical colleges.

Medical education had been a special area of study in the early years. There was an Indian Association for Medical Education (IAME), having its own journal appearing regularly. Persons like A. Lakshmanswami Mudaliar, V Ramalingaswami and P.N. Wahi had headed this association. However, with the steep decline in the quality of medical education over time, people lost interest in this field and it has virtually withered away. This, incidentally, the very poor state of leadership in the medical profession.

This link up of the rich well off class of Indians (Brown Englishmen/Americans) with their counterparts in the rich Western countries has played a major part in creating the dominant position for Western medicine and a virtual disappearance of the indigenous systems from the country today. These changes have occurred at an exponential pace over the past three decades or so, which had seen an even sharper class polarization in the in the wake of what the IMF had called Structural Adjustment Programme. GATT, World Bank and WTO joined IMF in promoting globalization in India. These have ushered in profound qualitative and quantitative changes in the entire system of medical education, research and practice in the country, leading `commoditization' of medical education and practice. This trend is in line with what Gunnar Myrdal had observed soon after Independence: Alienation of these national political leaders from the masses, their westernized values, their lack of competence, their reluctance to come to grips with urgent social problems, along with pressure from certain powerful vested interests, both from within the country and from abroad, all combined to induce the leaders to depend heavily on foreign agencies for 'technical' and monetary assistance. The appeal of the Western conceptual approach drew further strength from the fact that it is well fitted to rationalisation of opportunistic interests in the westernized elite of developing countries. This has been the root cause of the inability to fulfill their earlier promise of strengthening the scientific base of practice of the indigenous systems of medicine.

The decimation of the state funded health service system enormously expanded the space for private initiative. Indeed, the state itself extended assistance to the private sector in the form of various types of duty exemptions and incentives. The breakdown of the public health system rapidly expanded the `market' for the private sector. The governments were also made to undertake a most unimaginative regime of `cost recovery' from the pitiably meagre allocations made for the government funded health services.

The government's moves towards globalization further increased this trend of commoditization of medical services. There has been a mushrooming growth of numerous unregulated profiteering private hospitals, nursing homes, diagnostic centres and other ancillaries of the medical industry. With unabashed political support, unregulated institutions for education of physicians and other health personnel such as dentists, nurses, homeopaths and vaids have rapidly expanded in the private sector as it became a lucrative field for making profits.

The all round deterioration of public sector institutions in health fields and a very rapid growth of the private sector which is confined mostly to the field of medical (and not health) care has had a

devastating impact on ISM and other coping mechanisms that the people of this country had been adopting before it got overwhelmingly dominated by practice of Western medicine, that too of the private sector kind.

All these trends point to what Ivan Illich (15) had long ago mentioned as medicalisation of life. Generating dependence – almost addiction – to medicine and generation of iatrogenesis of various kinds, were mentioned by him as maladies of the market driven `modern' medicine. This `addiction' is particularly tragic for the hundreds of millions of poverty stricken people of the country. It is a case of Marie Antoinette Syndrome – why not eat cake, if they do not get bread? Of late Amartya Sen has come to realize this gross injustice to the deprived in his book, *The Idea of Injustice*.

Conventional public health organisations have virtually ceased to perform the function of preventive work. Even the work of epidemic control has sharply deteriorated. Information system to identify even outbreaks of epidemics and emergency action to control them, as was done even in the colonial days, has long ceased to exist. Even the few of the outbreaks that get reported in news media elicit tepid response from the authorities, including pivotal investigative agencies. People, including those who pretend to take their side, meekly submit to outbreaks of several `epidemics of epidemics'.

The political leadership was impelled to `remember' this state of affairs when they had to garner votes to come to power for the 2004 Lok Sabha elections. They repeated what they have been promising for more than 55 years about their concern about the health status of the deprived sections. This time they pledged to increase the percentage of the GDP allotted for public health from 0.9 per cent to `2-3' per cent within their term. They launched what they termed as the National Rural Health Mission (NRHM) by Brown Americans. NRHM has failed miserably to stick to the timeline they had set to attain their objectives in their Mission Document (16). That the NRHM did not pay attention to the key area of health manpower and support system is a glowing instance of the design structure of NRHM. It however served the purpose of once again deceiving the masses for another five years. NRHM plods along into the new term of the government to put up a façade of action which, conforming to what Myrdal had stated, has been going on during the past 62 years.

Conclusion

The Medical Council of India has to play the pivotal, multifaceted role of bringing about social orientation of medical education of high quality for which the Parliament of India enacted the necessary law to empower it to perform these duties. It has conspicuously failed in performing its statutory obligations right from the time when it was required to accord a key position to the teaching of preventive and social medicine to students. The MCI itself has fallen victim of the social, political and economic forces which has shaped the perverse power relations in India. Reversing this situation is a gigantic political task. The vast masses of the deprived people of the country have to embark on a long, grinding political struggle to wrest their rights from those who had usurped them since India gained independence. Struggle to ensure that the MCI acquires the capabilities to perform the task for which it was formed becomes a part of the wider political struggle to usher in an equitable society in the country.

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192 JAIN, MANISH (Centre for Studies in Sociology of Education, Tata Institute of Social Science Deonar, Mumbai400088). BEYOND DESKILLED WAGE LABOURER, TEACHERS AS TRANSFORMATIVE INTELLECTUAL.

In a recent paper Dholakia and Jain (EPW, June 20, 2009) have argued that given the financial and budgetary constraints, the Indian state cannot hope to achieve UEE if it pays teachers the salaries recommended by the Sixth pay Commission. They propose that if private players and NGOs who pay low salaries to teachers are allowed to run primary schools then UEE may be realized. This paper places these proposals in the context of emerging research and funding networks with Tooley as a key figure, larger discourses about teacher accountability, efficiency, management, absenteeism and political economy of educational reforms in the 1990s that paved way for increasing stratification of educational provision and access and NGOisation. It point to the gaps, silences, interpretations and problematic of this research. This paper also delineates the political nature of these proposals and its consequences for teachers, teaching and education and outlines a countering idea of teacher and education drawing upon Giroux.

193 JAIN, PANKAJ (**Ahmedabad**). UNIVERSAL SCHOOLING IN INDIA:COMMON (Govt.) SCHOOLVISION VS. PP SOLUTION.

1. Maximal realistic State Education Budget (6%) of GDP, (ii) universal schooling up to high school, (iii) High Schooling Cost/ Teacher salary @ 7th Pay Commission recommendations are simply incompatible**.** This is an arithmetic fact, and can not be denied. (EPW Paper). Even critics do not find fault with or errors in the calculations.

   Given this fact, there are only two alternatives solutions (Different from Visions). First, increase the education spending much above 6% of GDP, which does not happen anywhere in the world (but can always be suggested as a part of Vision). Second, implement a solution that provides (comparatively) good education at a lower cost.

2. Universal quality school education and highly qualified/ competent teachers are not compatible**.** India has >200 million children in school going age. Assuming that each child must have one period daily for math, and one period of science, and that one can not teach more than 5 sessions a day, if one has to prepare a little to remain a good teacher, these children would require 40 million good math teachers and 40 million good science teachers.

   Indian academics is struggling to get a few thousand good eligible candidates to do Ph.D. in math or Sciences each, where are you then going to find these 80 million good math/ science teachers.

   The second critical fact of Universal School Education Solution is the need for it to rely on not so good teachers.

3. **Recommended Solution**: Gyan Shala design (and program) meets both the above requirements and hence is recommended as **an alternate and better (the only feasible) solution** for Universal Quality School Education, given the factual inevitability of 1st and 2nd above. GS is a non-profit, austere, NGO, PP example.

4. The Approach of Opposition who support only Government School and High Teacher Welfare as their Preferred Alternative, as a part of Common **Govt.** School (Egalitarian, democratic) Alternative

a. It tries to defeat the proffered alternative solution by comparing these not with any real functioning Common Govt. Schools, but by comparing it with an IDEAL VISION, that does not exist on ground, but can be sold through a political Economy Power (of Alliance of teachers & Education Hobbyists). Does not discuss the performance of two real life alternatives, but promote its preferred solutions by showing it to be closer to "Vision".

b. It rejects the alternative by terming it a 'non-school', through a definition of schooling which does not focus on 'children's learning level'. Instead focus of debate is shifted to 'teacher welfare, thus converting a school from a 'learning centres for children' to a 'teacher welfare centre', making it easy to politically sell the definition.

c. Discount or unquote powerful evidence in support of opposite solution. i.e. (i) children perform comparatively well on all measurable aspects, (ii) curriculum norms in this (GS) non-formal system are higher than of State Boards/ CBSE, (iii) pedagogy in this non-formal system is closer to known best practices compared to majority of others, (iv) time on learning tasks spent by the child on each core subject in this 3 hr. school is higher than that in most full day schools and any Government school.

d. Reject the alternate solution by terming it "unproven', having inadequate evidence, as if (i) something can really be proven in social sciences, and/ or (ii) there exists any proof/ evidence in favour of 'the comparative effectiveness of their own visionary solution in India'.

e. Exploit and promote popular misconceptions to discredit alternate solution and to mobilize support for its preferred solution:

- 3 hrs. of schooling is not adequate, though (three hours daily is enough for University Education).
- Govt. does not spend enough on its schools; BMC Schools spend Rs. 17000/- per year, on an average, on each child enrolled, without counting the cost of building/ land and mid-day meal.
- Indian Govt. teacher salary is low: In fact as a % of per capita national income, it is highest in the world.
- Indian Govt. spends less on education: In fact, at present, Govt. spending on elementary education is among world's highest, less than almost none.

The paper attempts to demonstrate that its preferred PP solution is not only 'inevitable and the only feasible one', but also that the recommendation of opponents are based on analytically weaker, though politically/ ideologically powerful perspectives.

194 HARIJAN, KEDAR NATH (Department of geography Jai Prakash University, Chapra). SCIENCE EDUCATION AND SCHEDULED CASTE SOCIETY.

The scheduled caste community is outcaste community in Hindu caste system; and this community of the society is far from education of general and science education in particular. They are socially boycotted and economically vulnerable.

The scheduled caste community has no right to get education in ancient period . Thus they are very backward on their all sphere of development in the society. An attempt will be made to analyse the causes of poor science education in particular among scheduled caste community in particular and other segment of society of general.

The main objective of the study :-

* To critically analyse the mode of science education system.
* To ascertain the root cause of low percent science education among scheduled caste community .
* To suggest the measures for better science education for the welfare of the nation.

The study will be based on primary data collected through questionnaires from selected rural and urban households.

195 PRADHAN, H.C And MODY, A.K. (Homi Bhabha Centre for Science Education, TIFR V.N. Purv Marg, Mankhurd, Mumbai 400088). PROBLEM SOLVING.

In This article we discuss the method that we have used for capacity building of undergraduate physics students in a college setup in Mumbai Universtiy. We have developed a problem solving course based on selected problems called touchstone problems from basic physics that is based on well defined criteria. The basic concepts are taught to students using constructivist approach to help them construct their own conceptual understanding while solving problems. In the entire process no formal teaching work is carried out. At the end we have summarized the characteristics of capacity building based on constructivism.

196 SAU, RANJIT (8/2, Alipore Park Road, Sonali Flat 2D Kolkatta 700027). THE SCIENCE OF SOCIETY: SPACE AGE WORLD AND STONE AGE MINDS

PEOPLES SCIENCE EDUCATION ABSTRACTS

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